RFP-1325.02 (REV. 10/97)
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FERRERA, K.P.		
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TUOR, N.R.		
VOORHEIS, G.M.		
Shelton, D.	X	
Sayton, C.	X	
Setlock, G.	X	
Motzl, K	X	
COR. CONTROL	X	X
ADMN. RECORD	X	X
PATS/T130G		

Reviewed for Addressee
Corres. Control RFP

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Date By

Ref Ltr. #

DOE ORDER # 5400.1

Mr. Tim Rehder
Rocky Flats Project Manager
US Environmental Protection Agency
999 18th Street, Suite 500, 8EPR-F
Denver, CO 80202-2466

Mr. Steve Tarlton
RFCA Project Coordinator
Colorado Department of Public Health and the Environment
4300 Cherry Creek Drive South, OE-B2
Denver, CO 80222-1530

Dear Tim and Steve,

Enclosed please find two copies of the Progress Report #3 to the Source Evaluation and Preliminary Mitigation Plan for Walnut Creek. This report is the third deliverable described in Section 6 of the Plan for Source Evaluation and Preliminary Proposed Mitigating Actions for Walnut Creek Water-Quality Results, Revision 2, dated September 15, 1997. In addition, a meeting is planned for January 13, 1998, as part of the monthly Surface Water Issues Meeting, to discuss the contents of this report. The final report will be submitted to you on April 15, 1998.

Please feel free to contact me at 966-4830 or John Stover at 966-9735 if you have any questions or require additional information.

Sincerely,

[signature] for

Steve Slaten
Regulatory Liaison Group

Enclosures

ADMIN RECORD
A-OU06-000537

cc w/Encs:
K. Schnorr, City of Broomfield
M. Harlow, City of Westminster
K. Korkia, CAB
J. Stover, RLG, RFFO
S. Slaten, RLG, RFFO
Administrative Record

cc w/o Encs:
J. Legare, AMEC, RFFO
B. April, RLG, RFFO
M. McCann, OCC, RFFO
D. Shelton, K-H
C. Dayton, K-H
G. Setlock, K-H
K. Motyl, RMRS

RF/RMRS-97-131.UN

KAISER•HILL
COMPANY

PROGRESS REPORT #3 TO THE SOURCE EVALUATION AND PRELIMINARY MITIGATION PLAN FOR WALNUT CREEK

RMRS Rocky Mountain Remediation Services, L.L.C.
...protecting the environment

REVISION 2

Environmental Restoration
Rocky Flats Environmental Technology Site

December, 1997

RF/RMRS-97-131.UN

Progress Report #3 to the Source Evaluation and Preliminary Mitigation Plan for Walnut Creek

December, 1997

U.S. Department of Energy

Rocky Flats Environmental Technology Site

Golden, Colorado

TABLE OF CONTENTS

FIGURES

TABLES

1. INTRODUCTION

This Source Evaluation Progress Report is provided in accordance with the Final Rocky Flats Cleanup Agreement (RFCA) (Attachment 5, §2.4(B)) under "Action Determinations". The RFCA requires reporting of "exceedances in Segment 5" and when "standards are exceeded at a POC" and that a "source evaluation and mitigating action will be required". Specifically, this source evaluation addresses the August 15, 1997 Rocky Flats Environmental Technology Site (Site) report of elevated 30-day moving averages for plutonium (Pu) and americium (Am) water-quality results in Walnut Creek. These elevated values were measured at the Point of Compliance (POC) monitoring location at Walnut Creek and Indiana Street (referred to as GS03) for the period June 12 through July 2,1997. Elevated values were also measured at the Point of Evaluation (POE) monitoring location above Pond B-1 (referred to as GS10) for the periods April 13 through April 24,1997, May 25 through June 20, 1997, August 2 through September 3, 1997, and September 22 through October 17, 1997. Finally, elevated values were observed at the POE monitoring location above Pond A-1 (referred to as SW093) for the period August 2, 1997 through August 3,1997. This Source Evaluation Progress Report #3 is the third in a series the Site has committed to completing as outlined in Source Evaluation and Preliminary Proposed Mitigating Actions for Walnut Creek Water-Quality Results, September 1997 (Revision 2; RF/RMRS-97-081.UN). This Plan was delivered to the Colorado Department of Public Health and the Environment (CDPHE), the Environmental Protection Agency (EPA), the City of Broomfield and the City of Westminster, on September 15, 1997.

The Site considers the recent elevated water-quality measurements at Site POCs and POEs serious in nature. Elevated values such as these have not previously been measured at GS03. The Site maintains open communication with regulators, cities, and stakeholders to relay the progress of the investigation. The Site has initiated a surface-water source investigation incorporating a variety of onsite and offsite expertise, as well as state-of-the-art research methods and technologies. The Site has initiated extensive data evaluations, additional field investigations (soil, sediment, and water analyses), and assessments of Site activities and monitoring programs. Activities and administrative changes have been implemented as quickly as practicable to determine the cause of these elevated measurements and continue to protect water quality. The Walnut Creek source location activities undertaken by the Site thus far, indicate that the GS03 exceedance is most likely the result of legacy contamination. The source evaluation has uncovered no information that indicates that recent Site activities are responsible.

In order to allow sufficient time for effective source evaluation while simultaneously providing the more frequent dissemination of information and results as they become available, a series of three Source Evaluation Progress Reports, and a Final Source Evaluation and Mitigating Action Plan will be completed. The Progress Reports have been produced at intervals during the source evaluation process as specific actions are completed. During the production of each deliverable, additional information will be collected which will be included in subsequent reports as available. Data collection schedules are often weather dependent (collection of runoff samples) and subject to laboratory analysis turnaround times. The scope of additional information collection is flexible and should be expected to change based on the knowledge gained during the source evaluation activities. The schedule is given in Table 1-1.

Table 1-1. Schedule of Deliverables.

Deliverable	Completion Date
Source Evaluation Progress Report #1	September 30, 1997; Completed
Source Evaluation Progress Report #2	November 17, 1997; Completed
Source Evaluation Progress Report #3	December 31, 1997
Final Source Evaluation Report and Mitigating Action Plan	April 15, 1998

Source evaluations require analysis of constituent fate, transport, and loading, as well as statistical analysis and the establishment of water-quality correlations which may indicate the location of a contaminant source. To date, no discrete source of surface-water contamination has been identified and quantified in Walnut Creek. Consequently, an evaluation of downstream impacts at this time would be premature. This Progress Report #3 describes the progress of source evaluation actions for Walnut Creek gaging stations GS03, GS10, and SW093 and covers data received by December 1, 1997. Source evaluations are required to determine the location, extent, and significance of areas which may have an impact on surface-water quality. This Source Evaluation Progress Report #3 includes the ongoing assessment of monitoring data for GS03 and GS10, and an assessment of existing data for SW093. The following is included in this Progress Report #3 for Walnut Creek:

- Hypotheses for source location(s) with supporting and non-supporting information, including preliminary results on source location;
- Results and analysis of ongoing RFCA monitoring;
- Updates to the ongoing GS03 and GS10 evaluations;
- An assessment of existing monitoring data for SW093;
- A description of new soil sampling locations in the GS03 drainage;
- Updates for the new Source Location monitoring stations[1] for GS03, GS10, and SW093;
- An evaluation of the effects that watershed improvements may have had on Site water quality;

[1] Source Location monitoring stations are automated gaging stations installed as part of a source evaluation under RFCA. These locations are installed according to the SW IMP Source Location decision rule and current Site automated surface-water monitoring practices. Operation of these gages is tailored to meet the requirements of each source evaluation.

- A summary of current Actinide Migration Study findings with cross-links to source evaluations; and

- A summary of the status for sampling and operational modifications.

2. BACKGROUND

2.1. SITE HYDROLOGY

Walnut Creek, the subject of this investigation and one of several Site drainages, flows east past the Site's boundary at Indiana Street. Surface-water monitoring station GS03 is located on Walnut Creek approximately 100 yards west of Indiana Street. Downstream of Indiana Street, flows are diverted around Great Western Reservoir via the Broomfield Diversion Ditch, and back to Walnut Creek. Walnut Creek then flows into Big Dry Creek, and on to the South Platte River.

Walnut Creek Tributaries

Upstream from station GS03, Walnut Creek receives flow from the following four tributaries (listed in order from north to south and shown in Figure 2-1):

- McKay Bypass Canal (Coal Creek water conveyance canal);

- No Name Gulch (buffer zone drainage basin east of the Landfill Pond);

- North Walnut Creek (northern Industrial Area (IA) drainage basin); and

- South Walnut Creek (central IA drainage basin).

No Name Gulch and the McKay Bypass Canal flow only during the spring or following large storm events, receive runoff from non-IA drainage basins, and are not controlled by detention ponds. The McKay Bypass is also used by Broomfield to transfer water from Coal Creek to Great Western Reservoir. Both North and South Walnut Creek, in contrast, have nearly continuous baseflow, receive runoff from the IA, and are controlled by a system of detention ponds. A discussion follows describing how water runs off the IA, into North and South Walnut Creeks, through the detention pond network, and, ultimately, into Walnut Creek where it continues to station GS03.

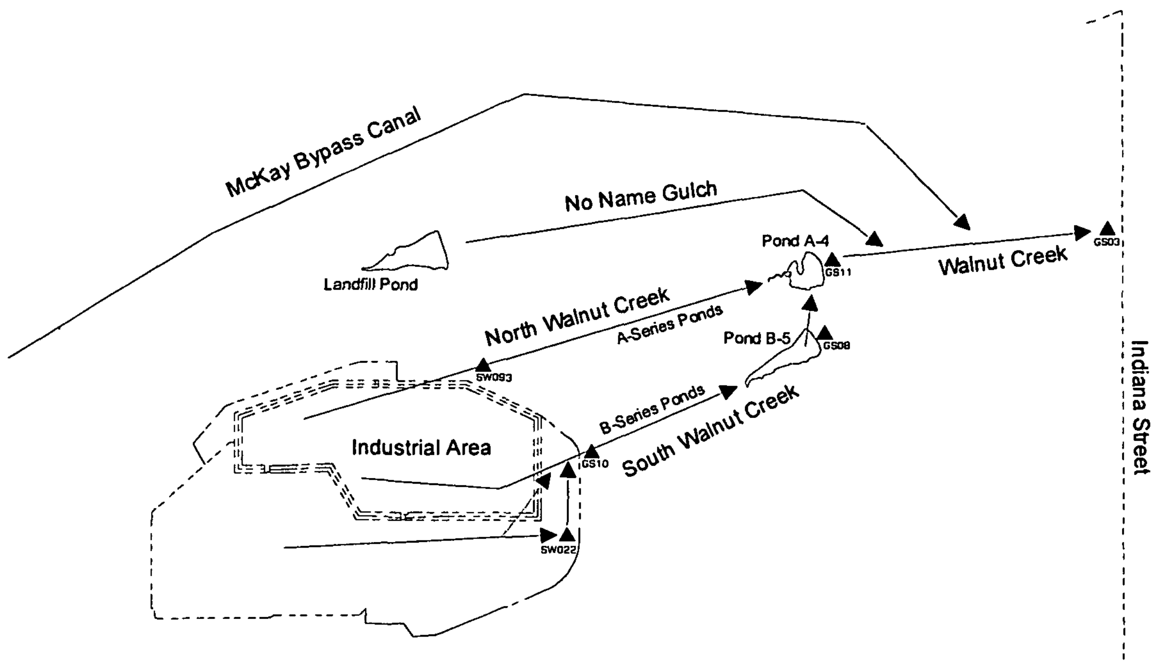

Figure 2-1. Hydrologic Connectivity of Site Drainage and Water Management Features.

North and South Walnut Creek Flow Controls

All IA surface-water runoff that flows into North or South Walnut Creek is collected in a system of Site detention ponds. The ponds serve three main purposes for surface-water management: (1) stormwater detention and settling of sediments, (2) water storage for sampling and, if necessary, treatment prior to release, and (3) emergency spill control in those instances where a spill cannot be adequately managed without use of the ponds.

South Walnut Creek water is routed through the B-Series ponds[2]. Steps in the normal water collection and transfer process are briefly outlined as follows:

- Runoff from the south-central IA flows through the Central Avenue Ditch to SW022, and then to GS10 (during high runoff periods, some water in the Central Avenue Ditch overflows to a large corrugated metal pipe and flows directly to GS10; shown by dotted line in Figure 2-1);

- Runoff from the central IA flows directly to GS10;

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[2] The Pond B-5 outlet works are scheduled to be upgraded in FY98. WWTP effluent, which normally flows to B-3 and then B-5, will be pump transferred to A-3 to keep B-5 de-watered. Stormwater flows to B-5 will be detained in B-5. This water will be periodically pump transferred to A-4 to keep the construction site dry. Once the B-5 outlet works are completed in February 1998, water will be direct batch discharged to Walnut Creek.

- Runoff from GS10 then flows downstream through conveyance structures to Pond B-4 and on to Pond B-5 where it is held; and

- Water held in Pond B-5 is pumped periodically in batches (approximately 9 per year) to Pond A-4.

North Walnut Creek water is routed through the A-Series ponds. Steps in the water collection and transfer process are summarized as follows:

- Runoff from the northern IA flows directly to SW093;

- Runoff from SW093 flows downstream into Pond A-3;

- Water is held in Pond A-3, then periodically (≈ 9 times per year) released in batches into Pond A-4; and

- After Pond A-4 is filled to about 50% of capacity, flows into Pond A-4 (from Ponds A-3 and B-5) are discontinued, thereby isolating the A-4 water from the rest of the pond network. A sample of the A-4 water is collected and analyzed by CDPHE, and if sample results indicate water quality standards are met, the "batch" of water is discharged through the outlet works of Pond A-4. Samples are collected of the Pond A-4 discharge water, at station GS11, and the water flows on to Walnut Creek and station GS03. These batch releases from Pond A-4 occur from 6 to 12 times per year, depending on the amount of precipitation received at the Site, and involve approximately 100 to 200 million gallons of water annually.

As indicated above, all of the IA runoff that flows into North and South Walnut Creeks is ultimately routed through Pond A-4, detained, and routinely sampled prior to being released to Walnut Creek. There is no source of runoff from the IA that can enter Walnut Creek without first passing through the pond system and then be discharged from Pond A-4. Downstream from Pond A-4, the only sources of surface-water entering Walnut Creek upstream of GS03 are No Name Gulch, the McKay Bypass Canal, or overland runoff directly into Walnut Creek.

2.2. GS03 MONITORING RESULTS

As specified in the Surface Water Integrated Monitoring Plan (SW IMP), the Site's Water Management & Treatment (WM&T) group evaluates 30-day moving averages[3] for selected radionuclides at RFCA POEs and POCs. Continuous flow-paced sampling is conducted at all RFCA POEs and POCs using automated

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[3] The 30-day average for a particular day is calculated as a volume-weighted average of a 'window' of time containing the previous 30-days which had flow. Each day has its own discharge volume (measured at the location with a flow meter) and activity (from the sample carboy in place that day). Therefore, there are 365 30-day moving averages for a location which flows all year. At locations which monitor pond discharges or have intermittent flows, 30-day averages are reported as averages of the previous 30 days of greater than zero flow. For days where no activity is available, either due to failed lab analysis or NSQ for analysis, no 30-day average is reported.

flow-measurement and sampling equipment[4]. This section presents recent evaluations of water-quality measurements at POC surface-water monitoring location GS03 (see Figure 2-3) which showed values above the POC Standard value of 0.15 pCi/L Pu and Am. GS03 is located on Walnut Creek west of Indiana Street. Results for 30-day moving averages using available data at GS03 are summarized below in Table 2-1 and are also plotted in Figure 2-2. The mean daily flow rate and available individual sample results are plotted in Figure 2-4.

Table 2-1. Water-Quality Information from GS03 for the Period: October 1, 1996 through October 29, 1997.

Location	Parameter	Date(s) 30-Day Average Above 0.15 pCi/L	Date(s) of Maximum 30-Day Average	Maximum 30-Day Average (pCi/L)	Volume Weighted Average for Period (pCi/L)
GS03	Pu-239,240	6/12/97 - 7/2/97	6/13/97 - 6/24/97	0.465	0.029
GS03	Am-241	6/13/97 - 6/24/97	6/13/97 - 6/24/97	0.256	0.016

For reference, the 30-day Pu average at GS03 was between 0.05 pCi/L and 0.15 pCi/L for the following periods: April 16 through 26, 1997; June 10 through 11, 1997; July 3 through 5, 1997; and August 5 through 26, 1997.

The individual analytical results for the composite samples collected around the period of these elevated 30-day averages have been carefully reviewed for accuracy. Based on past analytical results for this location, these elevated values are considered unusual, with historical measurements[5] being well below 0.05 pCi/L. Samples collected after the period of elevated measurements showed normal Pu and Am activities. Individual composite sample results and details are shown in Table 2-2 for the periods of interest.

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[4] Through the use of a Data Quality Objectives (DQO) process, the SW IMP specifies the target number of composite samples ('carboys' receiving multiple grabs) to be collected at each monitoring location. The IMP further specifies that these carboys should be flow-paced. The flow pacing is based on the predicted stream discharge using historical record for each location. For example (for a specific location), if two carboys are targeted for a certain month, and the historical discharge volume is 100,000 gallons, then each carboy should represent 50,000 gallons. Grab samples of 200 ml are collected; smaller grabs push the repeatability limits of the auto-sampler. Since the carboys can hold 15 L, and the minimum volume for analysis is ≈ 5 L; the samplers are programmed to place 10 L (50 grabs) in the carboy. So, for 50,000 gallons, the sampler is programmed for 1 grab per 1,000 gallons (50,000 gals/50 grabs). Targeting 50 grabs allows for periods of discharge greater than expected (up to 75 grabs) without having to collect additional carboys. Similarly, periods of discharge less that expected (25 grabs) may still yield enough sample for analysis.

[5] Historical values are available in the Site Annual Environmental Reports and the Quarterly Environmental Monitoring Reports.

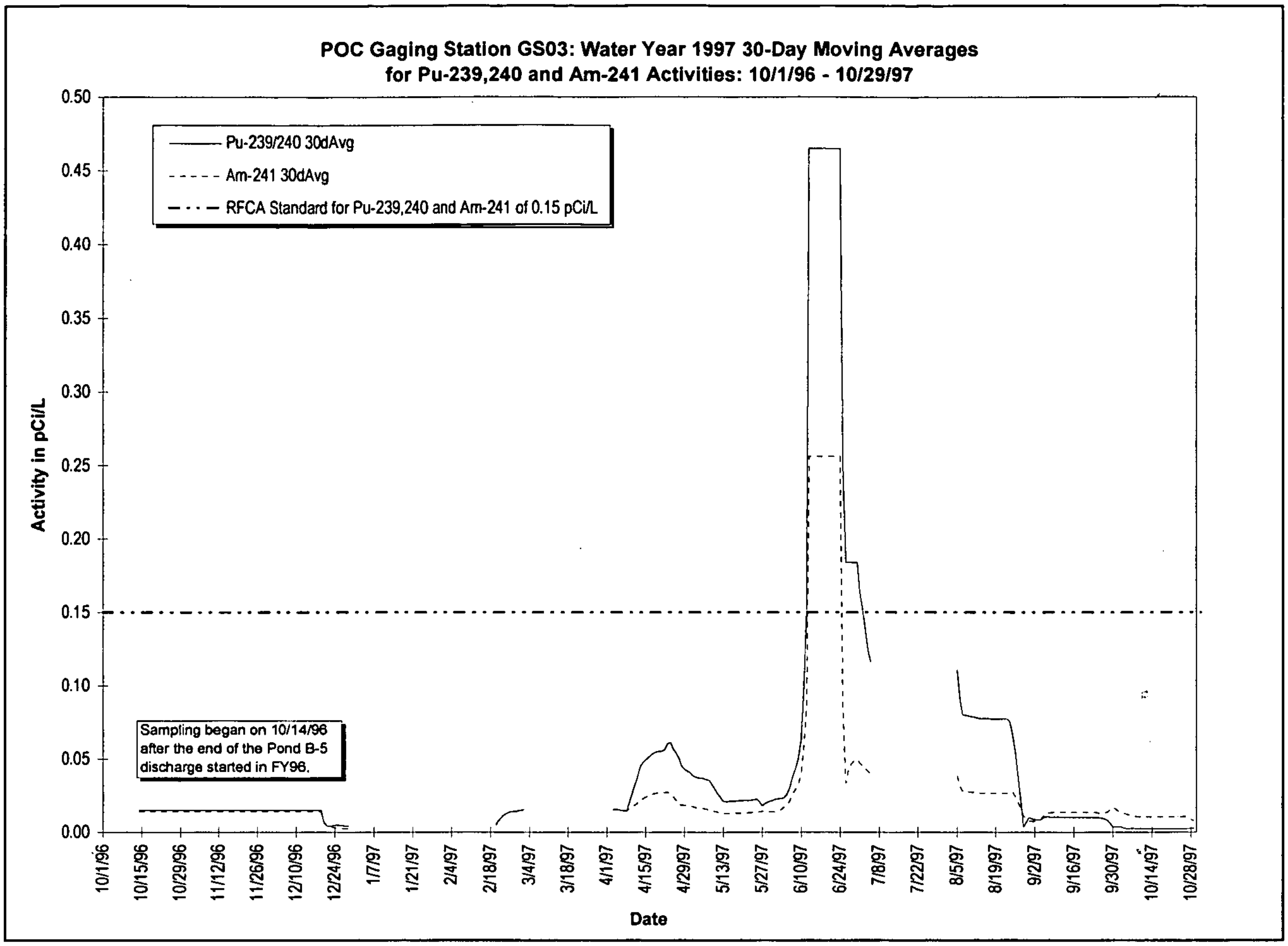

Figure 2-2. Gaging Station GS03 30-Day Averages: October 1, 1996 through October 29, 1997.

The composite sample at GS03 for the period May 15, 1997 through June 25, 1997 was collected during low flow conditions between Pond A-4 (the terminal pond for North Walnut Creek) discharges. It should be noted that this produced a low volume sample (NSQ[6]), relative to radio-analytical protocols which recommend a minimum sample volume of 4 liters to produce accurate radio-analytical results. The two composite samples at GS03 for the period June 25, 1997 through July 1, 1997 were collected as the first 2-of-3 composites during a Pond A-4 discharge (See Table 2-3 for Summary of Pond Discharges). Analytical

[6] For situations where non-sufficient quantity (NSQ) is collected for analysis, either due to equipment failures or exceptionally low streamflows, the SW IMP specifies that the sample may be discarded. NSQ for GS03 occurs occasionally for baseflow periods. At GS03, the SW IMP targets 1 carboy for the periods of baseflow between Terminal pond discharges. The SW IMP further specifies that the carboy must represent only baseflow, and must be removed from the sampler at the beginning of a Terminal pond discharge. Therefore, if flows significantly less than predicted are measured at GS03, the flow-paced carboy may not receive sufficient volume for analysis before it must be removed from the sampler.

results for composite samples from POC gaging station GS11 (location shown on Figure 2-3), which monitors controlled discharges from Pond A-4, showed no elevated readings for Pu-239,240 or Am-241 for the discharges which occurred during the period of elevated measurements at GS03. Table 2-4 and Figure 2-5 summarize these results.

These results indicate that water discharged from the Site's Terminal Ponds is not the source of the elevated measurements at GS03. This information suggests that the source of the Pu and Am measured at GS03 is downstream of the Terminal Ponds or located in a tributary to Walnut Creek in the Terminal Pond-to-GS03 stream reach. This area has no known sources of significant contamination. For reference, Figure 2-1 shows the hydrologic routing for drainages and water management facilities which are related to GS03.

Table 2-2. Selected Composite Sample Analytical Results for GS03.

Composite Sample Period	Pu-239,240 (pCi/L)		Am-241 (pCi/L)		Composite Sample Volume (Liters)	Walnut Cr. Discharge Volume During Sample Period (Million Gallons)
	Result	Error	Result	Error		
4/8 - 4/13/97	0.220	0.045	0.059	0.064	1.2[a]	5.31
5/15 -6/25/97[b]	0.465	0.129	0.256	0.116	1.0	0.34
6/25 - 6/27/97	0.165[c]	0.052	0.018	0.021	8.0	2.83
6/27 - 7/1/97	0.184	0.046	0.056	0.036	8.6	5.37
7/1 - 7/6/97	0.000[d]	0.006	0.024	0.022	8.4	4.11
8/5 - 8/8/97[e]	0.002	0.011	0.002	0.023	17.4	5.42
8/8 - 8/29/97	0.028	0.000	0.008	0.008	6.8	0.35
8/29 - 9/1/97	0.023	0.004	0.004	0.007	8.8	5.69

[a] Low sample volume (1.2 liter) due to frozen sampler lines; this sample did not give a 30-day Pu average above 0.15 pCi/L.
[b] Low sample volume (1 liter) due to dry weather and associated low flows.
[c] This is an arithmetic average for values of the first analytical run (0.206 pCi/L) and a rerun (0.124 pCi/L); error is the arithmetic average error.
[d] Actual result was -0.004 pCi/L for this sample; result was set to zero for practical reporting and calculation purposes.
[e] During the period from 7/6/97 - 8/5/97, the sampler collected an insufficient quantity for analysis due to unanticipated low flow rates.

Table 2-3. Summary of Terminal Pond Discharges for April 3, 1997 through December 5, 1997.

Location	Discharge Dates	Volume Discharged (gal)
Pond A-4	4/3/97 - 4/13/97	13,609,000
Pond B-5	4/28/97 - 5/12/97	15,450,000
Pond A-4	5/1/97 - 5/14/97	25,616,000
Pond A-4	6/25/97 - 7/6/97	13,319,000
Pond A-4	8/5/97 - 8/7/97	4,250,000
Pond A-4 Pond B-5	8/29/97 - 9/8/97 9/24/97 - 10/10/97	17,916,000 12,006,000
Pond A-4	10/1/97 - 10/10/97	9,606,000
Pond A-4	11/21/97 - 12/5/97	33,000,000 (estimated)

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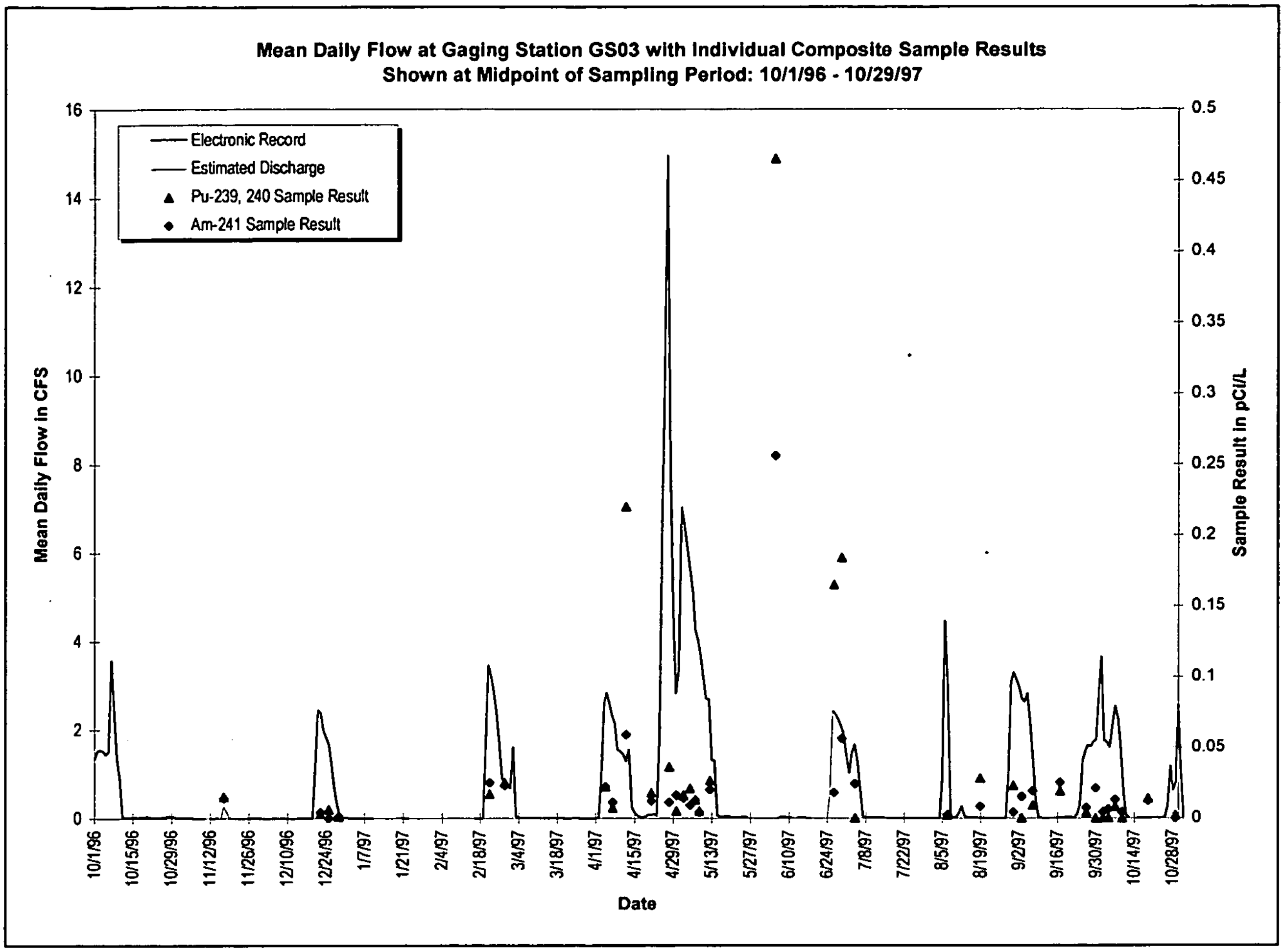


Intermittent peaks are from Terminal Pond A-4 and B-5 discharges; runoff peak (≈ 4/24 - 4/28) is from large snowmelt event. Sampling began on 10/14/96 after the completion of a B-5 discharge. Samples shown where data has been received from analytical labs (10/1/96 - 10/29/97).

Figure 2-4. Gaging Station GS03 Hydrograph and Sample Results.

During the time period of elevated measurements at GS03, no off-normal conditions were noted in decontamination and decommissioning (D&D), special nuclear material (SNM) stabilization, or environmental restoration (ER) activities that may have affected water quality, nor were there any closure activities occurring in the Walnut Creek drainage between Pond A-4 and Indiana Street. An initial walk-down of the Walnut Creek drainage between GS03 and Pond A-4 was conducted on August 15, 1997 and revealed no unusual conditions which might provide insight into elevated radionuclides in surface water for the May-July timeframe. Immediately downstream of station GS03 the water flowed offsite and was diverted around Great Western Reservoir, thus the downstream effect cannot be quantified since there were no receptors. Pond A-4 and B-5 discharges during this period showed normally low Pu and Am levels (as shown in Table 2-4 and Table 2-5, respectively).

Table 2-4. Composite Sample Analytical Results for GS11: April 8 through October 10, 1997.

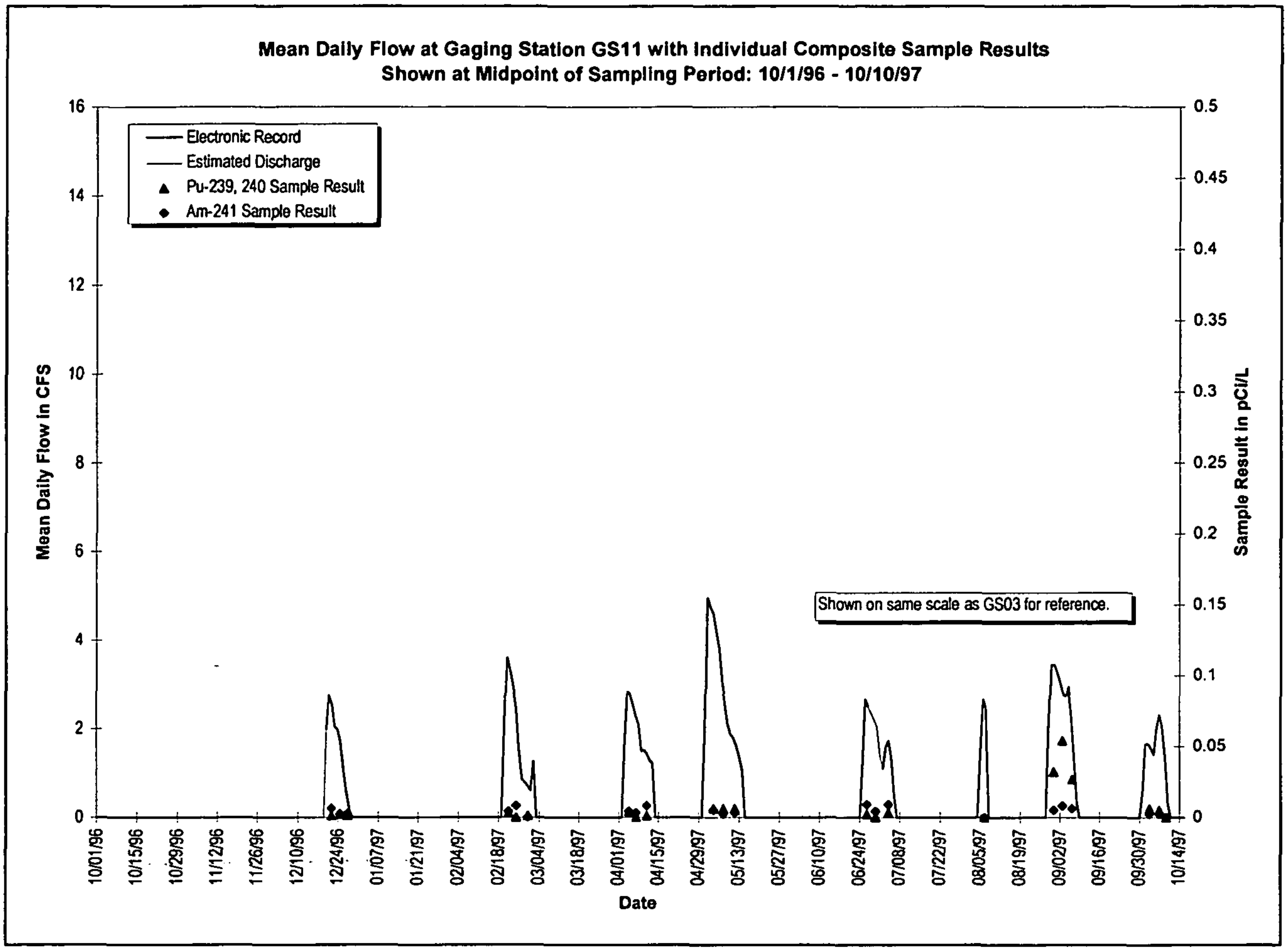
Composite Sample Period	Pu-239,240 (pCi/L)		Am-241 (pCi/L)		Composite Sample Volume (Liters)	Pond A-4 Discharge Volume During Sample Period (Million Gallons)
	Result	Error	Result	Error		
4/8 - 4/13/97	0.001	0.005	0.008	0.012	8.2	4.98
5/1 - 5/6/97	0.006	0.004	0.005	0.007	17.4	14.61
5/6 - 5/8/97	0.006	0.005	0.002	0.006	6.8	3.85
5/8 - 5/14/97	0.006	0.004	0.003	0.005	10.6	7.16
6/25 - 6/27/97	0.002	0.005	0.009	0.011	9.4	3.42
6/27 - 7/1/97	0.000[a]	0.012	0.004	0.017	4.0	5.67
7/1 - 7/6/97	0.003	0.012	0.009	0.012	7.8	4.22
8/5 - 8/7/97	0.000[b]	0.008	0.000	0.013	13.8	4.25
8/29 - 9/1/97	0.032	0.003	0.005	0.006	10.6	6.62
9/1 - 9/4/97	0.054	0.000	0.008	0.006	11.2	5.78
9/4 - 9/8/97	0.027	0.003	0.006	0.008	10.8	5.51
10/1 - 10/5/97	0.006	0.008	0.002	0.007	10.6	4.04
10/5 - 10/8/97	0.005	0.009	0.002	0.021	11.4	3.75
10/8 - 10/10/97	0.000[c]	0.012	0.000[d]	0.017	6.4	1.81

[a] Actual result was -0.009 pCi/L for this sample; negative results are set to zero for practical reporting and calculation purposes.
[b] Actual result was -0.008 pCi/L for this sample.
[c] Actual result was -0.003 pCi/L for this sample.
[d] Actual result was -0.001 pCi/L for this sample.

Table 2-5. Composite Sample Analytical Results for GS08: April 8 through October 10, 1997.

Composite Sample Period	Pu-239,240 (pCi/L)		Am-241 (pCi/L)		Composite Sample Volume (Liters)	Pond B-5 Discharge Volume During Sample Period (Million Gallons)
	Result	Error	Result	Error		
4/28 - 5/1/97	0.017	0.006	0.013	0.016	12.6	5.38
5/1 - 5/6/97	0.006	0.003	0.000	0.011	5.8	4.92
5/6 - 5/12/97	0.008	0.004	0.005	0.005	13.2	5.15
9/24 - 9/26/97	0.001	0.010	0.022	0.024	6.8	2.49
9/26 - 9/30/97	0.000[a]	0.006	0.006	0.007	11.8	4.97
9/30 - 10/10/97	0.000[b]	0.010	0.010	0.023	10.6	4.54

[a] Actual result was -0.001 pCi/L for this sample; negative results are set to zero for practical reporting and calculation purposes.
[b] Actual result was -0.003 pCi/L for this sample.



Samples shown where data has been received form analytical labs (10/1/96 - 10/10/97).

Figure 2-5. Gaging Station GS11 Hydrograph and Sample Results.

2.3. GS10 MONITORING RESULTS

As specified in the SW IMP, the Site's WM&T group evaluates 30-day moving averages[3] for selected radionuclides and other parameters at gaging station GS10. GS10 receives flow from the central IA and monitors flow to South Walnut Creek via the B-1 bypass pipeline to Pond B-4 which flows into Pond B-5. Recent evaluations of water-quality measurements at POE surface-water monitoring location GS10 (located on South Walnut Creek just above Pond B-1 as shown on Figure 2-3) show values above 0.15 pCi/L for Pu and Am. Results for 30-day moving averages using available sample results at GS10 are summarized below in Table 2-6 and are shown on Figure 2-6.

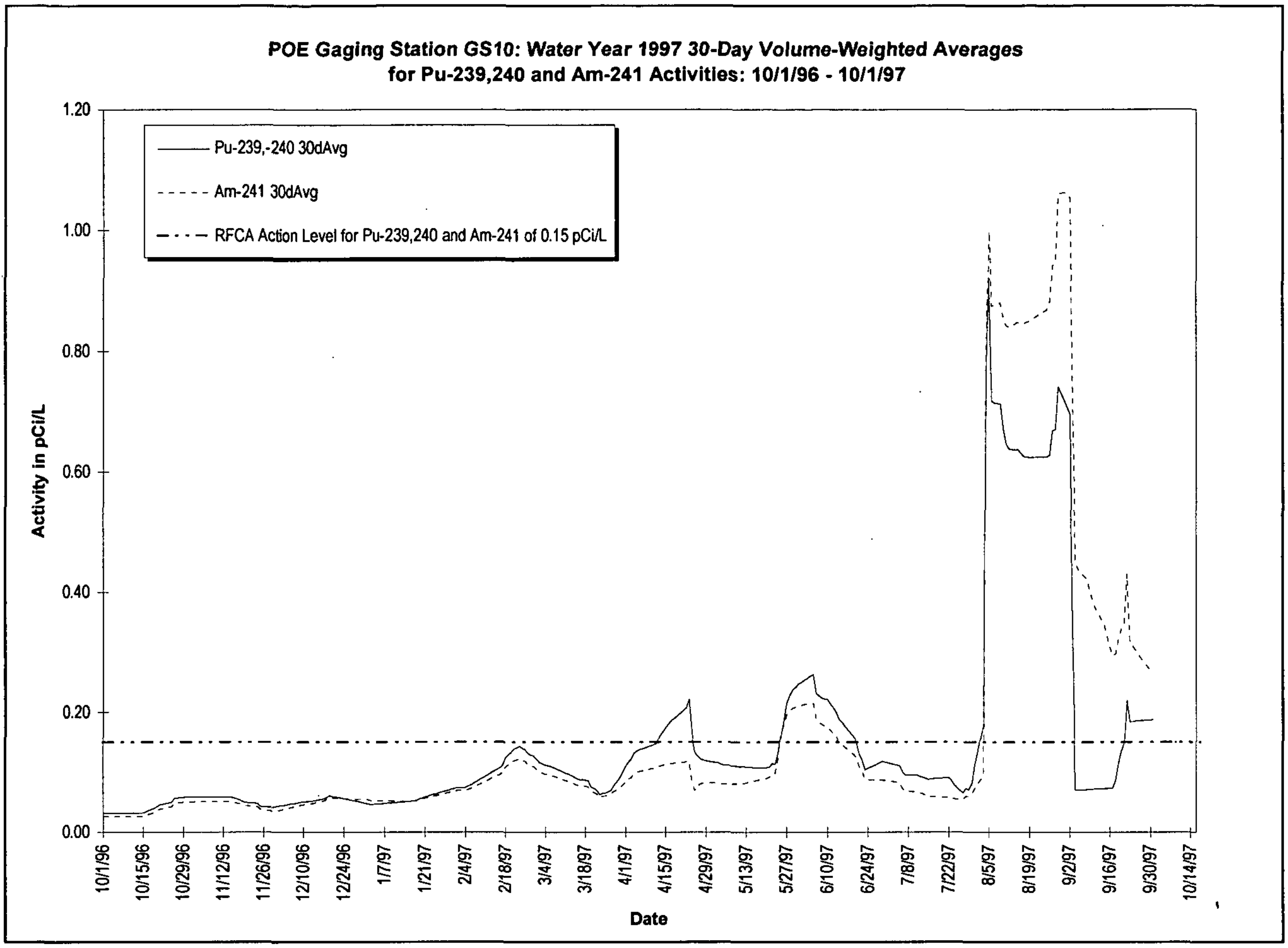


Figure 2-6. Gaging Station GS10 30-Day Averages: October 1, 1996 through October 1, 1997.

Table 2-6. Water-Quality Information from GS10 for the Period: October 1, 1996 through October 1, 1997.

Location	Parameter	Date(s) 30-Day Average Above 0.15 pCi/L	Date(s) of Maximum 30-Day Average	Maximum 30-Day Average (pCi/L)	Volume Weighted Average for Period (pCi/L)
GS10	Pu-239,240	4/13/97 - 4/24/97 5/25/97 - 6/20/97 8/2/97 - 9/3/97 9/22/97 - 10/1/97[b]	8/5/97	0.921	0.237
GS10	Am-241	5/25/97 - 6/14/97 8/4/97 - 10/1/97[b]	8/31/97	1.063	0.287

[a] Samples shown where data has been received from analytical labs (10/1/96 - 10/1/97).
[b] As of 10/1/97, the GS10 30-day average remains above 0.15 pCi/L.

The analytical results for the composite samples collected around the period have been verified. A review of historical monitoring data shows that these results are not unusual. Storm-event[7] samples collected at GS10 from 1992 through 1996 (under pre-RFCA protocols) had an arithmetic average Pu-239,240 activity of 0.23 pCi/L with a maximum of 1.4 pCi/L. The apparent upward trend during Water Year[8] 1997 is likely due to seasonally increasing flow rates which carry increased suspended material. The significant increase in activity during the first week of August 1997 likely occurred due to intense runoff events associated with summer monsoon weather patterns.

For reference, the 30-day Pu average at GS10 was between 0.05 pCi/L and 0.15 pCi/L for the following periods: October 26 through November 18, 1996; December 11 through 29, 1996; January 14 through April 12, 1997; April 25 through May 24, 1997; June 21 through August 1, 1997; and September 4 through 21, 1997.

All water monitored at GS10 during this period subsequently flowed to Pond B-5 and was transferred to Pond A-4 for subsequent discharge or direct discharged from B-5 to Walnut Creek. Pre-discharge samples of the water in Ponds A-4 and B-5 indicated acceptable water quality for all discharges. Analytical results from composite samples collected at gaging stations GS11 (Pond A-4 outfall) and GS08 (Pond B-5 outfall), during each discharge, were well below the RFCA standard (see Table 2-4 and Table 2-5). This improvement in water-quality between pond influent and effluent indicates that the Site's water-management practices help to reduce migration of contamination. Individual composite sample results and detail for GS10 are shown in Table 2-7 for the period of interest.

Table 2-7. Composite Sample Analytical Results for GS10: March 28 through October 2, 1997.

Composite Sample Period	Pu-239,240 (pCi/L)		Am-241 (pCi/L)		Composite Sample Volume (Liters)	S. Walnut Cr. Discharge Volume During Sample Period (Million Gallons)
	Result	Error	Result	Error		
3/28 - 4/2/97	0.300	0.026	0.140	0.015	6.0	0.29
4/2 - 4/11/97	0.150	0.017	0.110	0.021	8.8	1.37
4/11 - 4/24/97	0.410	0.041	0.140	0.019	12.2	2.45
4/24 - 4/25/97	0.086	0.014	0.045	0.009	12.8	1.60
4/25 - 4/26/97	0.070	0.012	0.033	0.009	11.0	2.41
4/26 - 5/12/97	0.086	0.014	0.120	0.017	4.0	2.70

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[7] Storm-event samples are generally flow-paced composites consisting of 15 grabs taken during a direct runoff hydrograph. The grabs are targeted to be taken on the rising limb.

[8] A water year (abbreviated as WY) is defined as the period October 1 through September 30.

Composite Sample Period	Pu-239,240 (pCi/L)		Am-241 (pCi/L)		Composite Sample Volume (Liters)	S. Walnut Cr. Discharge Volume During Sample Period (Million Gallons)
	Result	Error	Result	Error		
5/12 - 5/25/97	0.380	0.049	0.300	0.044	7.4	1.19
5/25 - 6/8/97	0.134	0.043	0.106	0.053	9.6	1.66
6/8 - 6/12/97	0.056	0.027	0.052	0.032	6.0	0.32
6/12 - 6/16/97	0.088	0.030	0.077	0.036	8.8	0.46
6/16 - 6/23/97	0.005	0.010	0.048	0.033	7.2	0.36
6/23 - 6/30/97	0.274	0.073	0.100	0.051	6.6	0.36
6/30 - 7/8/97	0.056	0.036	0.061	0.048	9.4	0.35
7/8 - 7/16/97	0.028	0.020	0.032	0.023	11.8	0.42
7/16 - 7/23/97	0.026	0.025	0.043	0.026	11.2	0.41
7/23 - 7/31/97	0.107	0.047	0.075	0.054	15.2	1.97
7/31 - 8/4/97	1.460	0.197	0.497	0.173	11.2	1.19
8/4 - 8/6/97	1.910	0.256	2.210	0.382	15.4	2.24
8/6 - 9/1/97	0.070	0.002	0.468	0.006	15.0	3.42
9/1 - 9/18/97	0.077	0.034	0.130	0.080	10.2	0.76
9/18 - 9/23/97	0.427	0.072	0.687	0.151	15.0	1.72
9/23 - 10/2/97	0.104	0.024	0.097	0.022	7.0	0.53

2.4. SW093 MONITORING RESULTS

As specified in the SW IMP, the Site's WM&T group evaluates 30-day moving averages[3] for selected radionuclides and other parameters at gaging station SW093. SW093 receives flow from the northern and central IA and monitors flow to North Walnut Creek which then enters the A-1 bypass pipeline to Pond A-3 which is batch discharged into Pond A-4. Recent evaluations of water-quality measurements at POE surface-water monitoring location SW093 (located on North Walnut Creek above Pond A-1 as shown on Figure 2-3) show values above 0.15 pCi/L for Pu. Results for 30-day moving averages using available data at SW093 are summarized below in Table 2-8 and shown on Figure 2-7.

A review of historical monitoring data shows that these results are not unusual. Storm-event samples collected at SW093 from WY92 through WY96 (under pre-RFCA protocols) had an arithmetic average Pu-239,240 activity of 0.73 pCi/L with a maximum of 5.3 pCi/L. The apparent upward trend during WY97 is likely due to seasonally increasing flow rates which carry increased suspended material. The significant increase in activity during the first week of August 1997 likely occurred due to intense runoff events associated with summer monsoon weather patterns. To the best of the Site's knowledge, no off-normal conditions were reported or experienced at any D&D, SNM stabilization, or ER activities during this time period that could have affected water quality.

Table 2-8. Water-Quality Information from SW093 for the Period: October 1, 1996 through October 5, 1997.

Location	Parameter	Date(s) 30-Day Average Above 0.15 pCi/L	Date(s) of Maximum 30-Day Average	Maximum 30-Day Average (pCi/L)	Volume Weighted Average for WY97 to Date (pCi/L)
SW093	Pu-239,240	8/2 - 8/3/97	8/3/97	0.181	0.039

[a] Samples shown where data has been received from analytical labs (10/1/96 through 10/5/97).

For reference, the 30-day Pu average at SW093 was between 0.05 pCi/L and 0.15 pCi/L for the following periods: October 1, 1996 through January 9, 1997; April 25, 1997; July 26 through August 1, 1997; and August 4 through 31, 1997.

All water monitored at SW093 during this period subsequently flowed to Pond A-3, was batch discharged to Pond A-4, and was subsequently batch discharged to Walnut Creek. Pre-discharge samples of the water in Pond A-4 indicated acceptable water quality for all discharges. Analytical results from composite samples collected at gaging station GS11 (Pond A-4 outfall) during each discharge were well below the RFCA standard (see Table 2-4). This improvement in water-quality between pond influent and effluent indicates that the Site's water-management practices help to reduce migration of contamination. Individual composite sample results and detail for SW093 are shown in Table 2-9 for the period of interest.

Table 2-9. Composite Sample Analytical Results for SW093: July 21 through October 6, 1997.

Composite Sample Period	Pu-239,240 (pCi/L)		Am-241 (pCi/L)		Composite Sample Volume (Liters)	N. Walnut Cr. Discharge Volume During Sample Period (Million Gallons)
	Result	Error	Result	Error		
7/21 - 7/29/97	0.208	0.063	0.037	0.074	10.2	0.46
7/29 - 7/30/97	0.224	0.063	0.247	0.087	13.4	0.78
7/30 - 8/1/97	0.037	0.025	0.026	0.034	8.0	0.39
8/1 - 8/4/97	1.330	0.213	0.628	0.166	12.8	1.18
8/4 - 8/6/97	0.085	0.035	0.044	0.037	15.0	2.70
8/6 - 8/12/97	0.020	0.200	0.036	0.201	13.0	2.81
8/12 - 9/1/97	0.002	0.005	0.016	0.005	8.4	1.89
9/1 - 9/18/97	0.002	0.009	0.000	0.014	12.4	0.79
9/18 - 9/23/97	0.018	0.016	0.033	0.028	15.0	1.66
9/23 - 10/6/97	0.000[a]	0.002	0.005	0.017	6.0	0.86

[a] Actual result was -0.003 pCi/L for this sample; negative results are set to zero for practical reporting and calculation purposes.

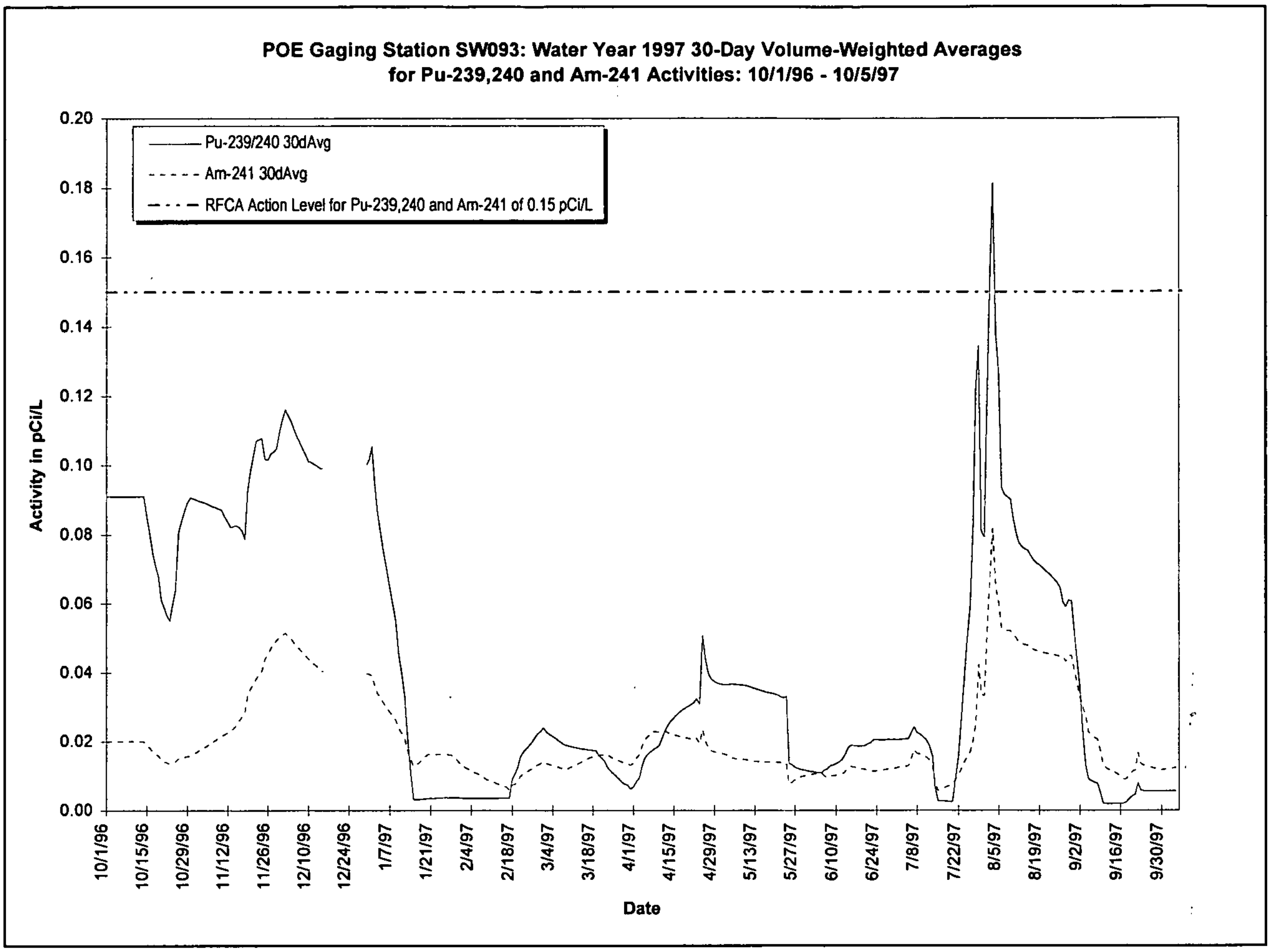

Figure 2-7. Gaging Station SW093 30-Day Averages: October 1, 1996 through October 5, 1997.

3. DATA SUMMARY AND ANALYSIS FOR GS03

All IA runoff and Wastewater Treatment Plant (WWTP) effluent tributary to Walnut Creek pass through the Terminal Ponds A-4 and B-5. Since discharges from A-4 (GS11) showed no elevated activities during the period of elevated activities at GS03 (as discussed in Section 2.2), it is assumed that the source of the radionuclide activity at GS03 is downstream from the Terminal Ponds. Therefore, Progress Report #1 primarily included analysis and interpretation of environmental information for the GS03 drainage from the Site Terminal Ponds to Indiana Street, including tributaries. New information collected since Progress Reports #1 and #2 is included in the following section. A cross-referenced discussion of this information and the specific source location hypotheses they support or not are included in Section 5.1.

3.1. AUTOMATED SURFACE-WATER MONITORING DATA

This section presents data summary and analysis for environmental information collected at gaging stations GS03 (Walnut Creek at Indiana Street), GS08 (Pond B-5 outlet), and GS11 (Pond A-4 outlet) as shown in Figure 2-3. Data from Source Location monitoring stations GS33 and GS35 has not been returned from the labs as of November 30, 1997 (see Section 10.2). Data presented include flow rates, discharge volumes, radionuclide activities, radionuclide loads, water-quality parameters, and precipitation. Analysis was performed on averages of all data available from WY93 to present, the continuous flow-paced samples from WY97, and the specific periods of recent elevated measurements[9]. The following section includes results from continuous flow-paced sampling since Progress Reports #1 and #2. Although both Pu and Am were elevated at GS03, this section focuses on the transport and source location for Pu only.

3.1.1. Data Summary

Significant data exists for flow and radionuclide activities at the gaging stations of interest. Information for total suspended solids (TSS), metals, and major ions is limited. Additional information for these parameters will need to be collected should the progress of the source evaluation indicate the need. Individual results are averages of target, duplicate, and replicate results for each sample. Validated results which were rejected are not included. All activities are for total radionuclides.

Surface-Water Flow Rates and Discharge Volumes

Reliable flow records have been collected at GS03, GS08, and GS11 since WY93. Site Terminal Pond discharges to Walnut Creek represent an average of 69% of the volume annually measured at GS03. However, this average is highly influenced by the very high runoff volumes in WY95. For WY93, WY94, WY96, WY97, and WY98, the Terminal Pond discharges represent 94% of the volume measured at GS03. Variation of flow rates and discharge volumes is significant in Walnut Creek, and coincides with variation in precipitation (as shown on Figure 3-1 and Figure 3-2). Significant gains in flow rates are seen at GS03 for the spring months as overland flow occurs in the drainage between the Terminal Ponds and GS03. Additionally, tributaries and seeps contribute relatively more water during these months.

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[9] Flow data is included for the period 10/1/92 - 11/30/97; analytical data is included for the period from 10/1/92 - 11/30/97, where available from the labs.

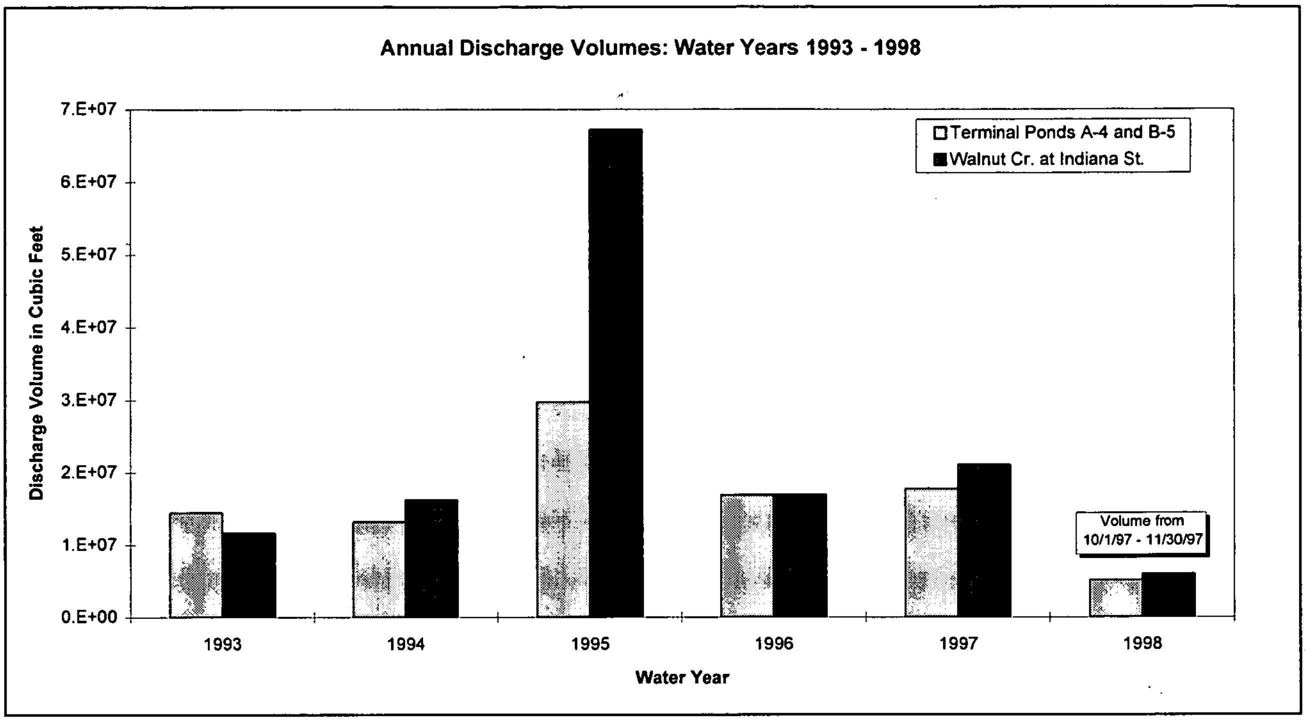


Figure 3-1. Annual Discharge Volumes for Walnut Creek.

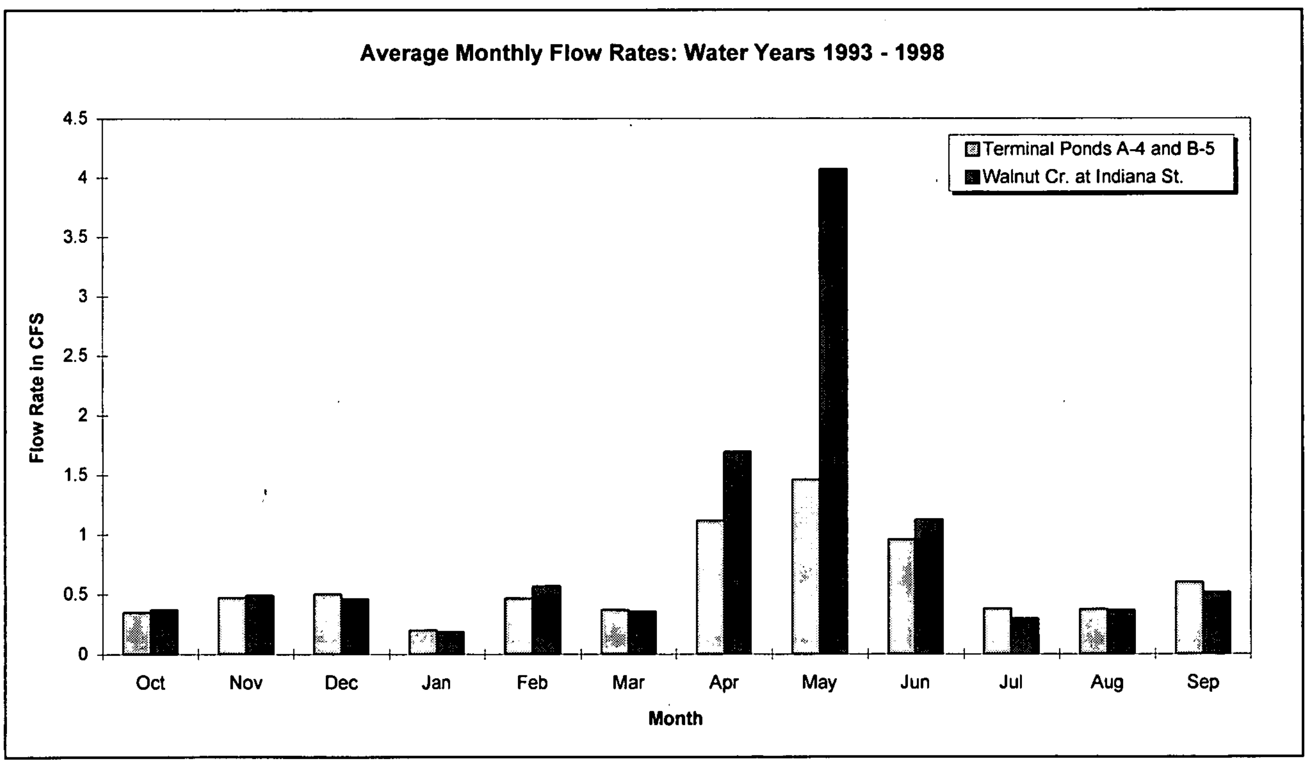


Figure 3-2. Average Monthly Flow Rates in Walnut Creek.

Radionuclide Activities

Individual analytical results for Pu are shown in Figure 3-3. The higher values in WY95 for the Terminal Ponds were a result of very high runoff volumes and the subsequent emergency discharge of Ponds A-4 and B-5 before adequate settling of contaminants could be achieved. All sample results are plotted regardless of sampling protocol employed[10]. The recent elevated results at GS03 can be seen on the right side of the plot. The unusual magnitude of these measurements is apparent. Summary statistics for these results are shown in Table 3-1. These summary statistics indicate that there may be a decrease in water quality between the Terminal Ponds and Indiana Street. However, when the WY97 results are not included, the average activity at GS03 is not different than the average activities for the Terminal Ponds. Therefore, the drainage may have changed somehow to give the elevated values. It should be noted that these activities are arithmetic averages, which do not take into account the hydrologic conditions during sampling (storm-event, baseflow, etc.) or the flow rate (more importantly, the discharge volume) associated with the measured activity.

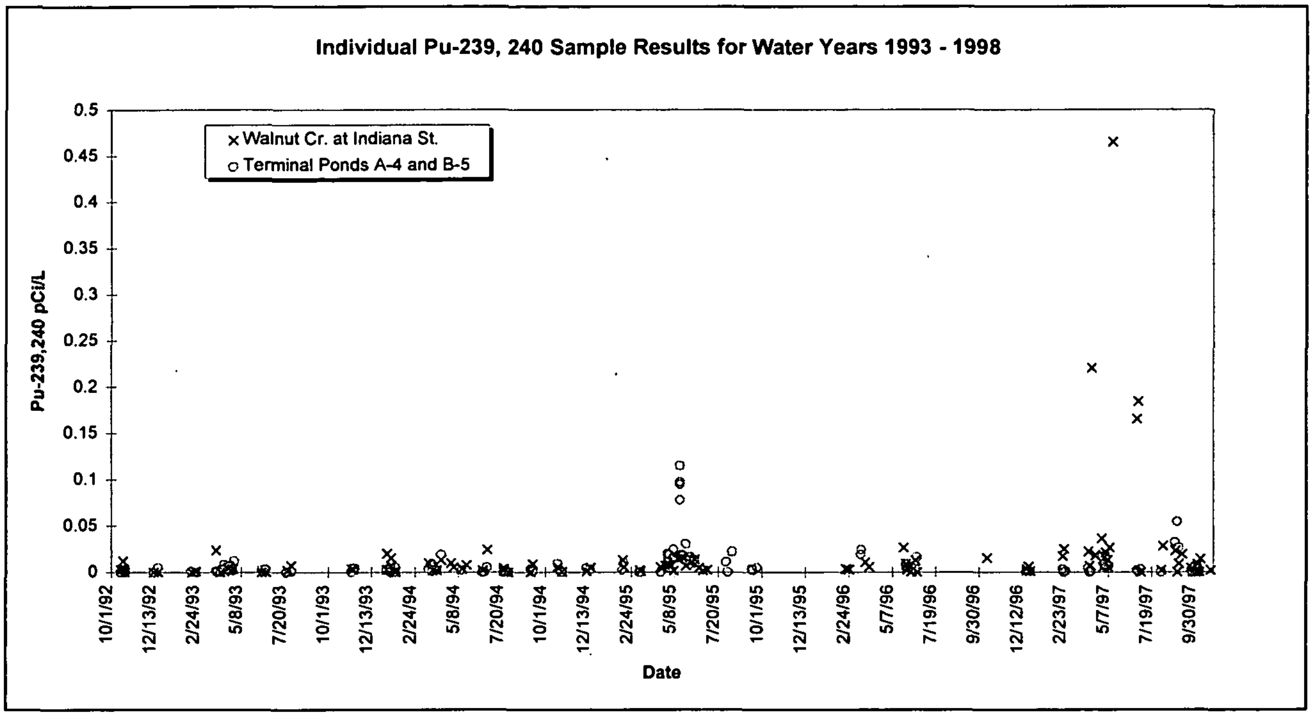


Figure 3-3. Individual Analytical Pu Results for Walnut Creek.

[10] Individual grabs, time-paced (scheduled grabs) composites, storm-event (hydrograph rising limb) flow-paced composites, and continuous flow-paced composites are shown. For a discussion of sample collection methods, see Section 6.2.4 in Progress Report #1.

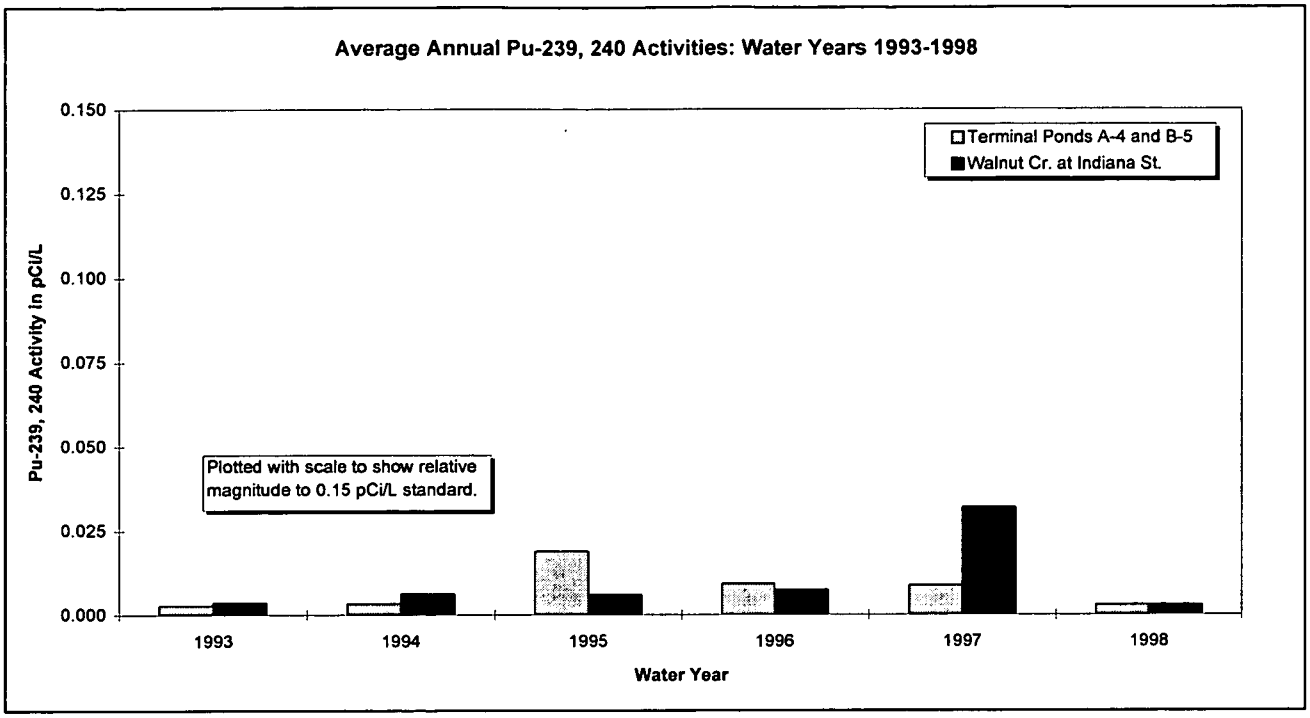
Table 3-1. Summary Statistics for Plutonium Samples from Pond A-4, Pond B-5, and Walnut Creek at Indiana Street.

Sampling Location[a]	Number of Samples	Average[b] Activity (pCi/L)	Maximum Result (pCi/L)	Standard Deviation[c] (pCi/L)
Walnut Creek at Indiana Street				
GS03	38	0.037	0.465	0.087
W+I	68	0.006	0.026	0.006
All	106	0.017	0.465	0.054
Pond A-4				
GS11	26	0.006	0.054	0.012
A4EFF	72	0.007	0.097	0.016
All	98	0.007	0.097	0.015
Pond B-5				
GS08	6	0.005	0.017	0.007
B5Eff	18	0.023	0.115	0.028
All	24	0.019	0.115	0.026

[a] Rocky Flats Environmental Database System location codes are shown; GS03 and W+I are co-located; GS11 and A4EFF are co-located; GS08 and B5EFF are co-located.
[b] Arithmetic average
[c] Assumes normal distribution

Figure 3-4 shows the relative average annual activities in Walnut Creek for WY93 - WY98. For WY93 - WY96, arithmetic averages are plotted. However, due to the continuous flow-paced sampling protocols currently in place, more representative volume-weighted average activities are shown for WY97 - WY98. It is important to note that although elevated measurements were made in WY97, the GS03 volume weighted average for Pu is still below 0.05 pCi/L (0.032 pCi/L). Although average activities seem to have changed significantly, the changes are small when taken in context with the levels of activity (to less than 1/100th of a pCi). In fact, the apparent change in activity may be due to the change in sampling protocols, and not a reflection of actual changes in the drainage. This change in sampling protocols, from grab and storm-event sampling to continuous flow-paced sampling, was discussed further in Section 6.2.4 in Progress Report #1.

It is generally agreed that Pu tends to form strong associations with particulate matter (see Section 9.1 for references). If contaminated particles are transported in surface water, and Pu mass correlates directly with the suspended particulate mass, then the observed Pu levels could be correlated with the amount of TSS. The data collected at GS10 is a good example (Figure 3-5) of this phenomenon. During high intensity precipitation events, with increased raindrop impact, higher quantities of solids are transported in overland flow. Similarly, higher flow rates in ditches and creeks generally result in increased TSS values due to higher flow velocity and turbulence. Additionally, seasonal changes in biological and chemical processes may influence Pu transport. Figure 3-6 shows monthly arithmetic average activities which increase for months with higher rainfall and flow rates which are shown on Figure 3-2.



Volume-weighted WY97 and WY98 average is plotted. WY98 is for period 10/1 - 10/29/97.

Figure 3-4. Average Annual Pu Activities for Walnut Creek.

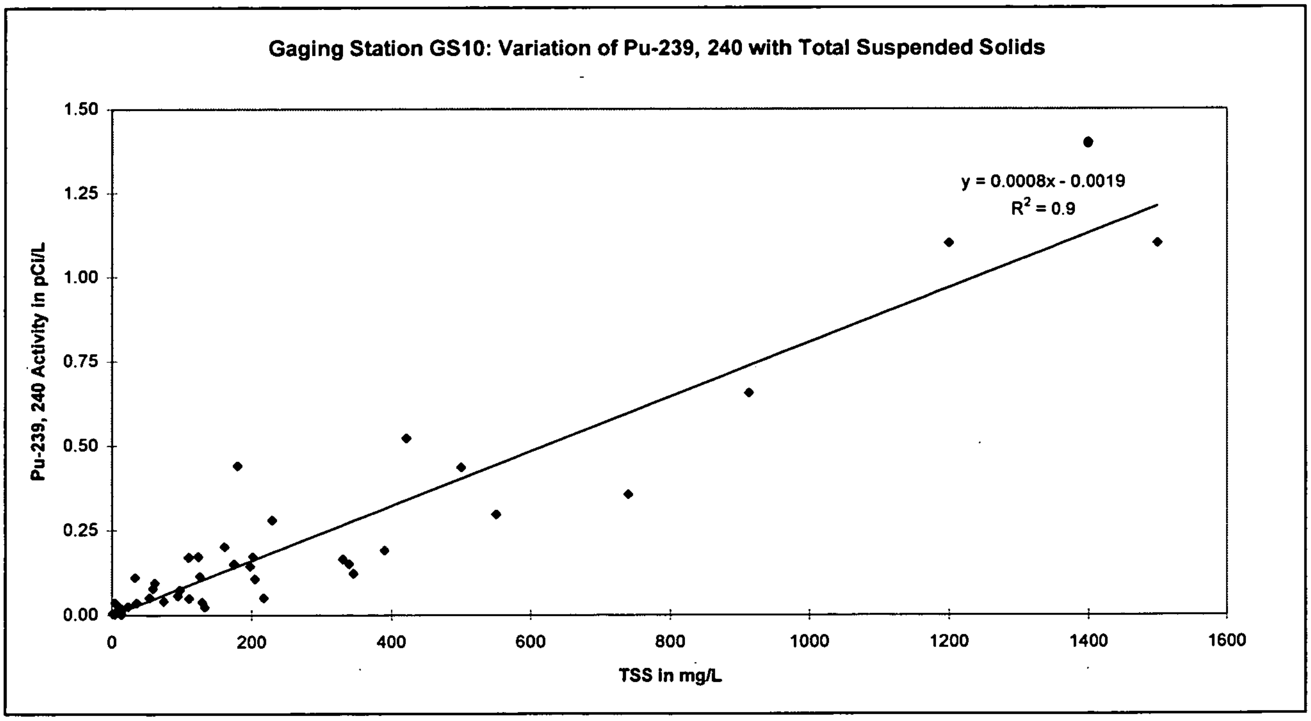
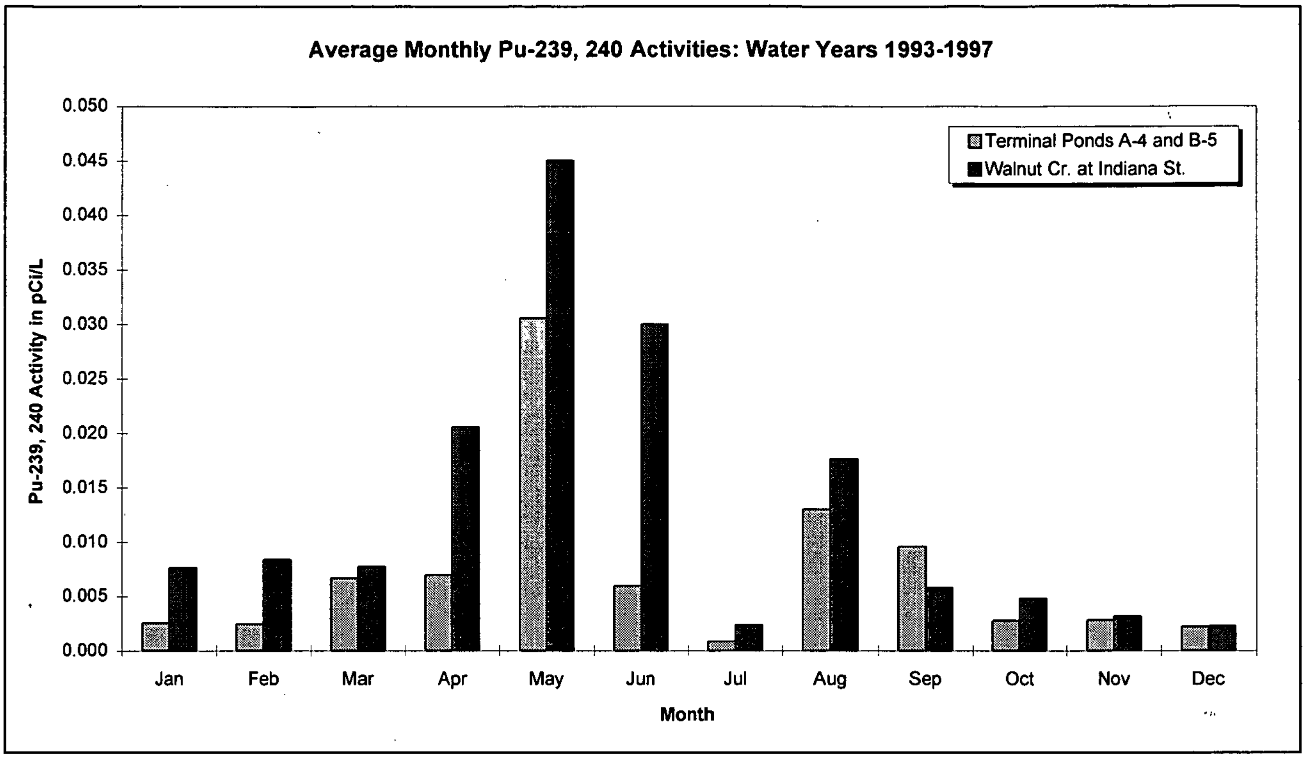


Figure 3-5. Variation of Pu with Total Suspended Solids at GS10.



All averages are arithmetic.

Figure 3-6. Average Monthly Pu Activities in Walnut Creek.

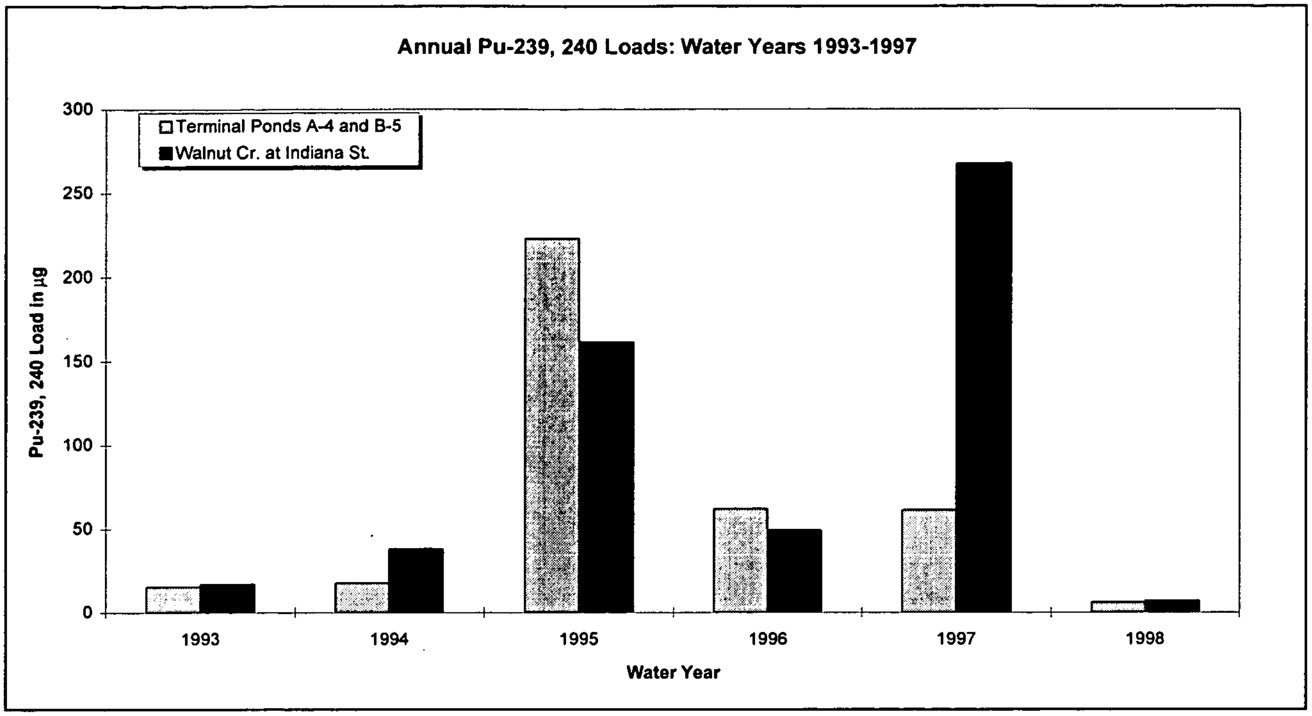
3.1.2. Loading Analysis

WY93 - WY98 Monitoring Data

Annual loads in micrograms are plotted in Figure 3-7. For WY93 - WY96, the annual arithmetic average activity of sample results is multiplied by the associated total annual discharge volume, then converted to micrograms. For WY97 and WY98, the activity for each flow-paced composite sample is multiplied by the associated discharge volume during the sample, then converted to micrograms and totaled.

The annual gain/loss in Pu load between the Terminal Ponds and Indiana Street is plotted in Figure 3-8. Losses in load are plotted as negative values. A gain indicates that Pu entered the stream reach between the Terminal Ponds and Indiana Street. A loss indicates that Pu was lost to the streambed or to the sediments in the GS03 flume pond. The result for WY97 indicates that a source may exist in the reach below the Terminal Ponds.

Seasonal loads in micrograms are plotted in Figure 3-9. For all water years, the seasonal arithmetic average activity is multiplied by the associated average seasonal discharge volume, then converted to micrograms.



WY98 is for period 10/1 - 10/29/97.

Figure 3-7. Annual Pu Loads in Walnut Creek.

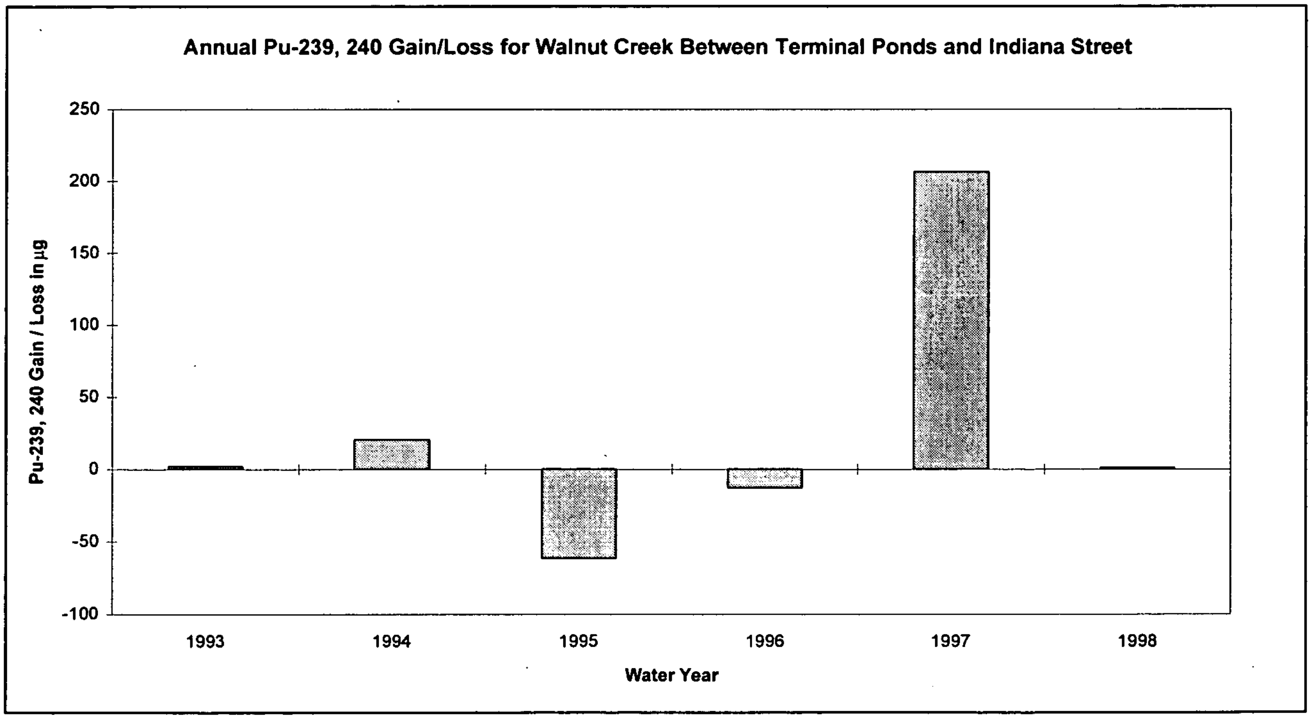


Figure 3-8. Annual Gain/Loss of Pu for Walnut Creek.

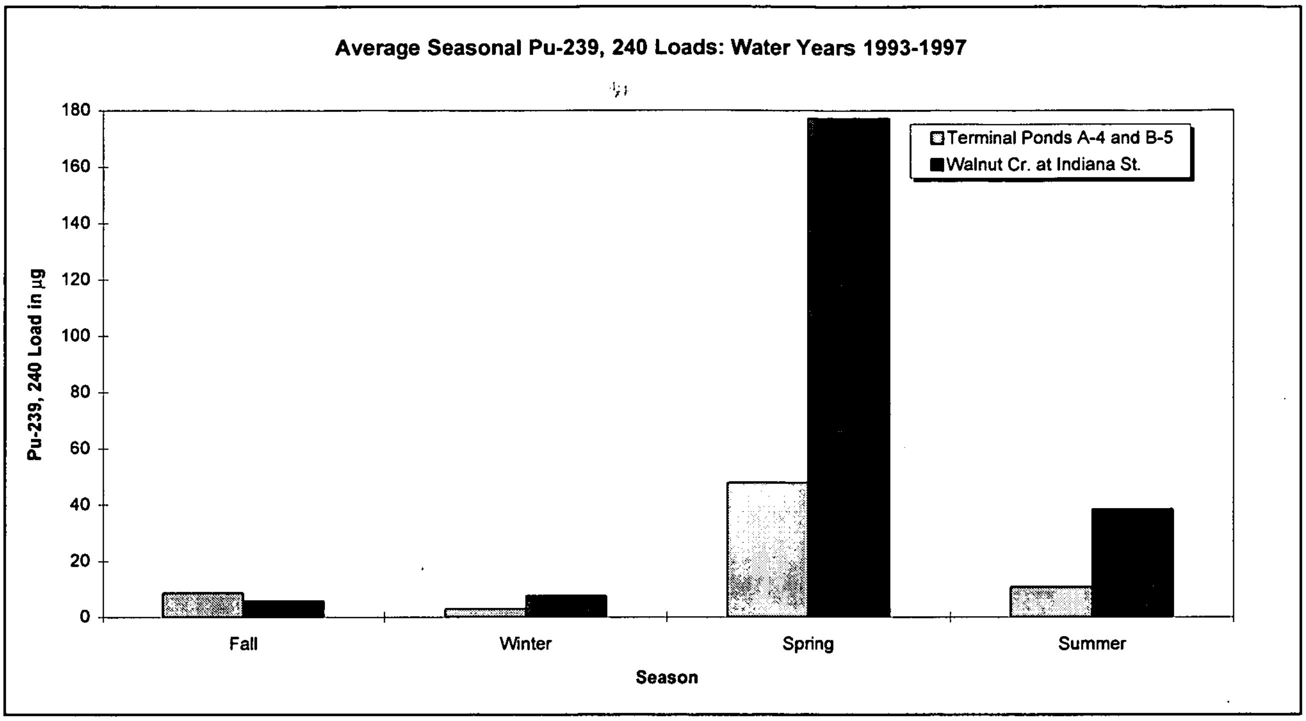


Figure 3-9. Seasonal Pu Loads in Walnut Creek.

The WY93 - WY98 average seasonal gain in Pu load between the Terminal Ponds and Indiana Street is plotted in Figure 3-10. A gain indicates that Pu entered the stream reach between the Terminal Ponds and Indiana Street. The largest gain occurs during periods of higher precipitation and the associated overland flow and increased flow rates.

WY97 and WY98 Continuous Flow-Paced Monitoring Data

Figure 3-11 shows volume-weighted average monthly activities for continuous flow-paced samples collected in WY97 and WY98. Analytical results are available through October 29, 1997. For most months, the activity increases between the Terminal Ponds and Indiana Street.

Detail for each continuous flow-paced composite sample at GS03 is presented in Table 3-2. Elevated samples are indicated in bold. Detail for each continuous flow-paced composite sample at GS08 is presented in Table 3-3. Detail for each continuous flow-paced composite sample at GS11 is presented in Table 3-4. It is important to note the highly variable activity for the GS03 samples, especially for the three consecutive samples collected during a pond discharge during the period June 25 through July 6, 1997 which shows that the activity drops off dramatically for the last sample. This seems to indicate a very intermittent source, a very localized source, or some sort of 'hot particle' mechanism (see Sec. 4.3). Regardless, it is apparent that the variability of surface-water activity and the transport mechanisms for Pu are not fully understood.

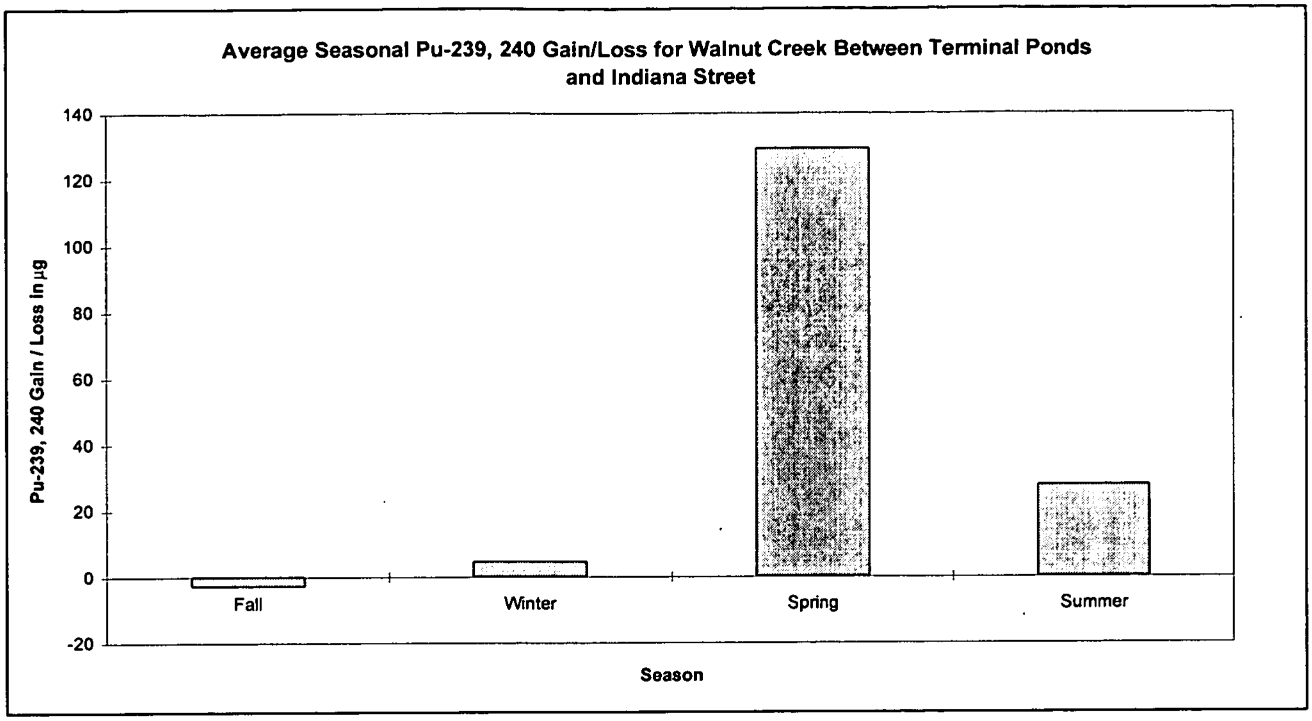


Figure 3-10. Seasonal Gain/Loss of Pu for Walnut Creek.

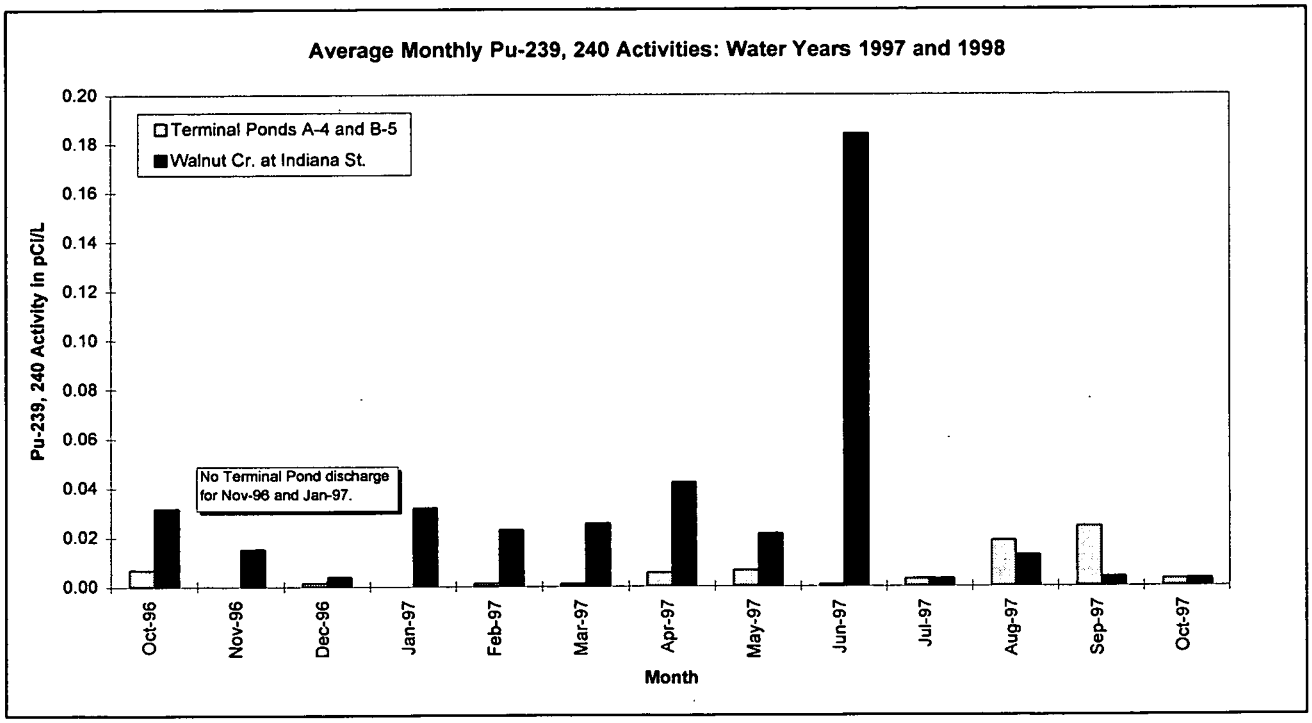


Figure 3-11. Average Monthly Pu Activities in Walnut Creek.

Table 3-2. Sample Detail for GS03.

Sample Start Time	Sample End Time	Discharge Volume During Sample (cubic feet)	Pu-239, 240 Activity (pCi/L)	Pu-239, 240 Load (micrograms)
10/1/96 0:00[a]	None	1481303	*0.032*	18.81
10/14/96 14:38	12/20/96 12:16	69687	0.015	0.42
12/20/96 12:16	12/23/96 11:39	610219	0.003	0.73
12/23/96 11:39	12/26/96 12:13	440743	0.006	1.05
12/26/96 12:13	12/30/96 14:32	124911	0.001	0.05
2/20/97 14:21	2/22/97 15:39	609170	0.017	4.13
2/22/97 15:39	3/3/97 11:08	1101256	0.025	10.98
3/3/97 11:08	4/3; NSQ[b]	9699	*0.032*	0.12
4/3/97 12:47	4/5/97 16:37	470746	0.022	4.13
4/5/97 16:37	4/8/97 17:12	624135	0.007	1.74
4/8/97 17:12	**4/15/97 11:16**	709435	**0.220**	62.26
4/15/97 11:16	4/26/97 16:28	1265362	0.018	9.09
4/26/97 16:28	4/28/97 13:57	2054116	0.036	29.50
4/28/97 13:57	5/1/97 16:25	1010904	0.005	2.02
5/1/97 16:25	5/3/97 14:07	1139103	0.016	7.27
5/3/97 14:07	5/6/97 12:04	1479879	0.021	12.40
5/6/97 12:04	5/7/97 13:16	442806	0.013	2.30
5/7/97 13:16	5/9/97 14:50	692467	0.005	1.38
5/9/97 14:50	5/15/97 7:40	1077900	0.027	11.39
5/15/97 7:40	**6/25/97 15:15**	45743	**0.465**	8.48
6/25/97 15:15	**6/27/97 13:35**	378015	**0.165**	24.88
6/27/97 13:35	**7/1/97 14:07**	719360	**0.184**	52.80
7/1/97 14:07	7/6/97 17:14	547709	0.000	0.00
7/6/97 17:14	8/5; NSQ[b]	13939	*0.032*	0.18
8/5/97 14:24	8/8/97 7:57	724257	0.002	0.58
8/8/97 7:57	8/29/97 12:55	47023	0.028	0.53
8/29/97 12:55	9/1/97 10:17	760556	0.023	6.98
9/1/97 10:17	9/4/97 10:42	752023	0.000	0.00
9/4/97 10:42	9/9/97 10:51	699115	0.009	2.51
9/9/97 10:51	9/24/97 17:15	23860	0.019	0.18
9/24/97 17:15	9/27/97 22:39	395717	0.004	0.63
9/27/97 22:39	10/1/97 15:58	572984	0.000	0.00
10/1/97 15:58	10/3/97 14:07	525014	0.000	0.00
10/3/97 14:07	10/5/97 13:42	292123	0.000	0.00
10/5/97 13:42	10/8/97 11:01	545216	0.008	1.74
10/8/97 11:01	10/10/97 16:16	283858	0.000	0.00
10/10/97 16:16	10/27/97 9:39	79270	0.014	0.44
10/27/97 9:39	10/30/97 15:39	325625	0.002	0.26

[a] Sampling began on 10/14/96, after the completion of a B-5 discharge started in FY96, activity set to WY97 volume-weighted average for loading calculation purposes.
[b] Sample had insufficient volume for analysis, activity set to WY97 volume-weighted average for loading calculation purposes.
Elevated samples are indicated in bold.

Table 3-3. Sample Detail for GS08.

Sample Start Time	Sample End Time	Discharge Volume During Sample (cubic feet)	Pu-239, 240 Activity (pCi/L)	Pu-239, 240 Load (micrograms)
10/1/96 0:00[a]	10/10/96 10:15	1535344	*0.007*	4.18
4/28/97 12:02	5/1/97 10:08	718814	0.017	4.87
5/1/97 10:08	5/6/97 14:51	658154	0.006	1.58
5/6/97 14:51	5/12/97 14:33	688436	0.008	2.20
9/24/97 14:28	9/26/97 15:10	333079	0.001	0.13
9/26/97 15:10	9/30/97 14:29	664923	0.000	0.00
9/30/97 14:29	10/10/97 13:30	606987	0.000	0.00

[a] B-5 discharge started in FY96 was not sampled, activity set to volume-weighted average to date for loading calculation purposes.

Table 3-4. Sample Detail for GS11.

Sample Start Time	Sample End Time	Discharge Volume During Sample (cubic feet)	Pu-239, 240 Activity (pCi/L)	Pu-239, 240 Load (micrograms)
12/20/96 8:05	12/23/96 8:58	705648	0.001	0.28
12/23/96 8:58	12/26/96 9:07	462124	0.002	0.37
12/26/96 9:07	12/28/96 7:17	105866	0.001	0.04
2/20/97 10:01	2/22/97 13:42	675876	0.003	0.81
2/22/97 13:42	2/25/97 13:52	685803	0.000	0.00
2/25/97 13:52	3/2/97 14:48	395895	0.001	0.16
4/3/97 10:08	4/5/97 16:12	552740	0.004	0.88
4/5/97 16:12	4/8/97 14:31	592151	0.000	0.00
4/8/97 14:31	4/13/97 11:11	665231	0.001	0.27
5/1/97 15:26	5/6/97 13:53	1952671	0.006	4.67
5/6/97 13:53	5/8/97 12:14	514592	0.006	1.23
5/8/97 12:14	5/14/97 11:46	957148	0.006	2.29
6/25/97 13:44	6/27/97 13:15	457604	0.002	0.37
6/27/97 13:15	7/1/97 13:49	758314	0.000	0.00
7/1/97 13:49	7/6/97 8:19	564141	0.003	0.68
8/5/97 11:15	8/7/97 15:14	568103	0.000	0.00
8/29/97 10:02	9/1/97 9:32	885503	0.032	11.30
9/1/97 9:32	9/4/97 10:04	772769	0.054	16.65
9/4/97 10:04	9/8/97 9:45	736736	0.027	7.79
10/1/97 14:13	10/5/97 13:13	540656	0.006	1.29
10/5/97 13:13	10/8/97 10:34	501448	0.005	1.00
10/8/97 10:34	10/10/97 10:45	242083	0.000	0.00

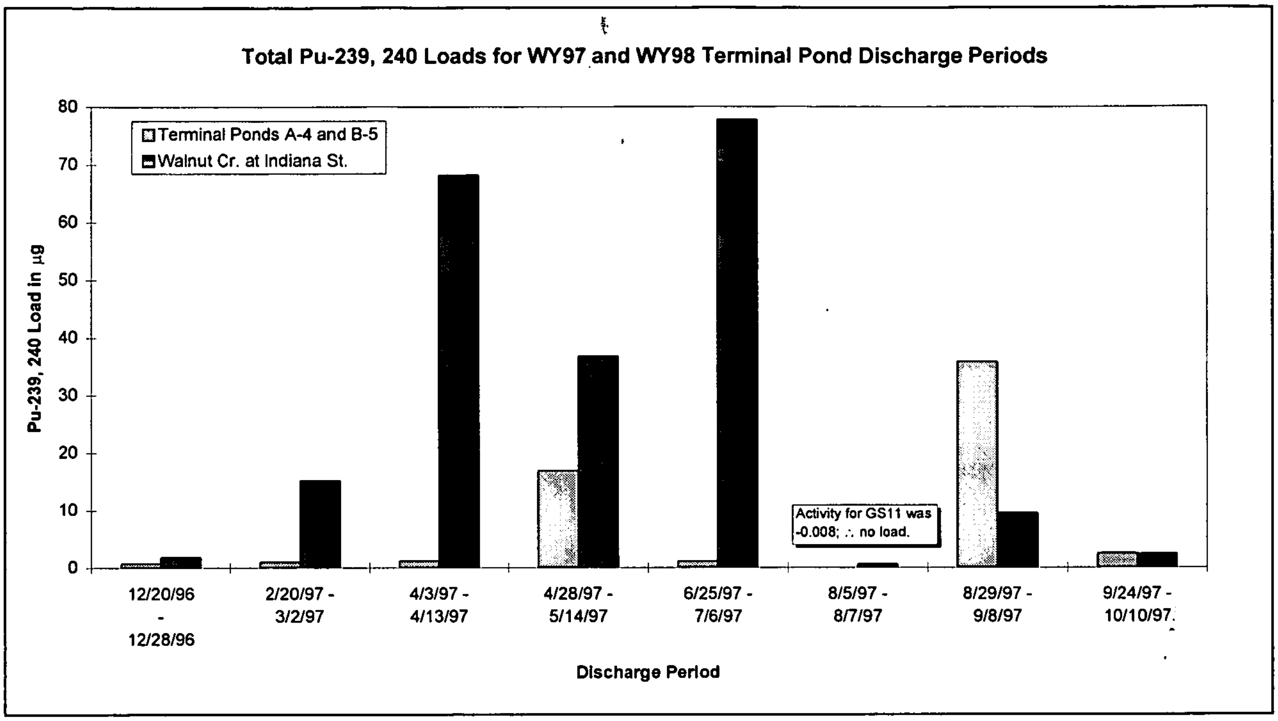


Figure 3-12. Walnut Creek Loads During WY97 and WY98 Terminal Pond Discharges.

Loads were calculated during Terminal Pond discharges to evaluate changes in loads as the discharge moved through the reach to Indiana Street. Figure 3-12 shows that for most discharges in WY97-WY98, loads increased between the Terminal Ponds and Indiana Street, indicative of a source in the drainage below the Terminal Ponds, or a tributary surface-water source.

3.1.3. Data Correlations

Flow Rates

As stated previously, Pu tends to form strong associations with particulate matter (as shown in Figure 3-5; references in Section 9.1). If these particles are transported in surface water, then so is Pu. During high intensity precipitation events, with increased raindrop impact, higher quantities of solids are transported in overland flow. Similarly, higher flow rates in ditches and creeks generally result in increased TSS values due to higher flow velocity and turbulence. Unfortunately, very few results exist for TSS at GS03. Recent sampling at GS03 has included TSS analysis, although results are often very low. Figure 3-13 shows the variation of Pu with TSS for recent samples collected at GS03. There are insufficient data to form a correlation. Results below the MDA of 5 mg/L TSS are not plotted.

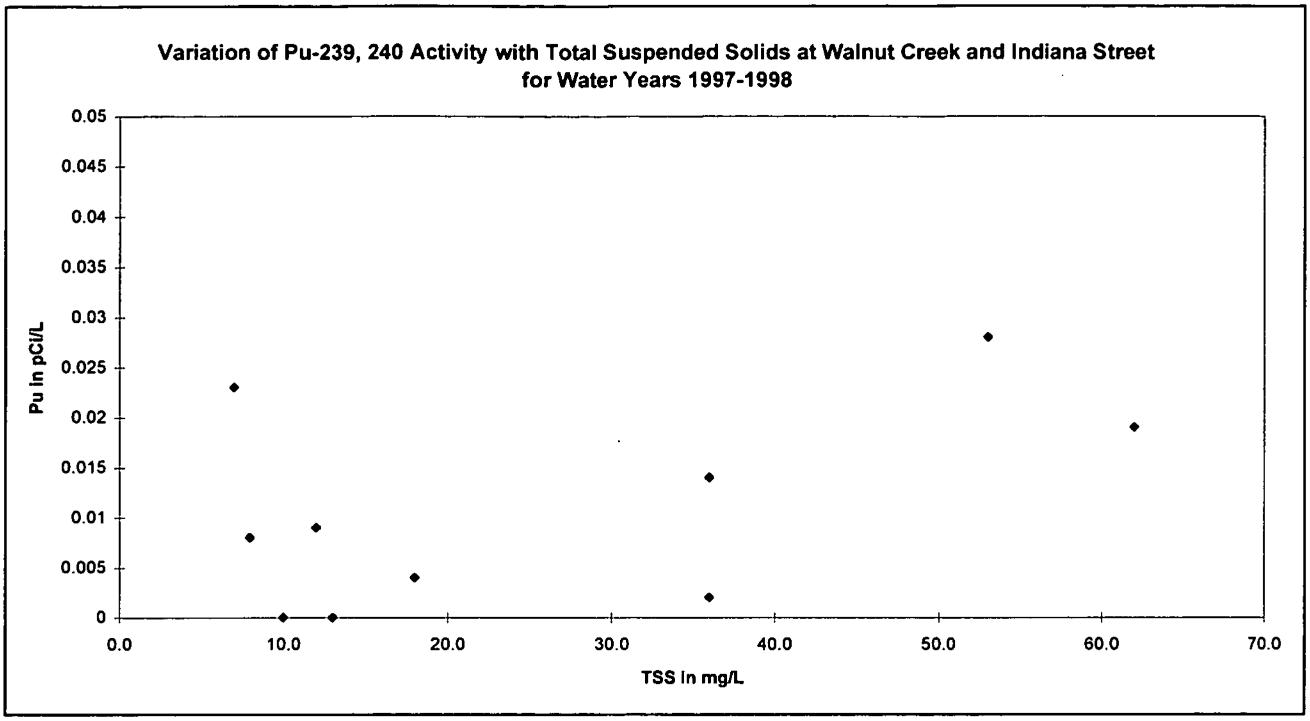


Figure 3-13. Variation of Pu with TSS at GS03.

Figure 3-14 shows the variation of Pu activity with flow for GS03. The activity plotted is the analytical result for the sample; the flow is the average of the flow rates during each composite grab. Figure 3-14 shows no trends that are indicative of a Pu source influenced solely by flow rate. An upward trend generally indicates the increased movement of Pu during higher flow rates. This can occur when the source is widespread (movement through increased overland flow), or when the source exists in the streambed itself (movement through increased scouring). These are the mechanisms commonly seen at other Site monitoring locations. A downward trend may indicate that groundwater is the source. For example, during low flow rates a contaminated groundwater source could make up the larger proportion of the flow and result in higher activities. If runoff or pond discharges that are relatively cleaner than the contaminated groundwater entered the creek, the groundwater source would be diluted, resulting in lower activities. Figure 3-14 seems to indicate that neither of these mechanisms are present. However, it may also indicate that there are multiple, potentially intermittent, mechanisms and sources.

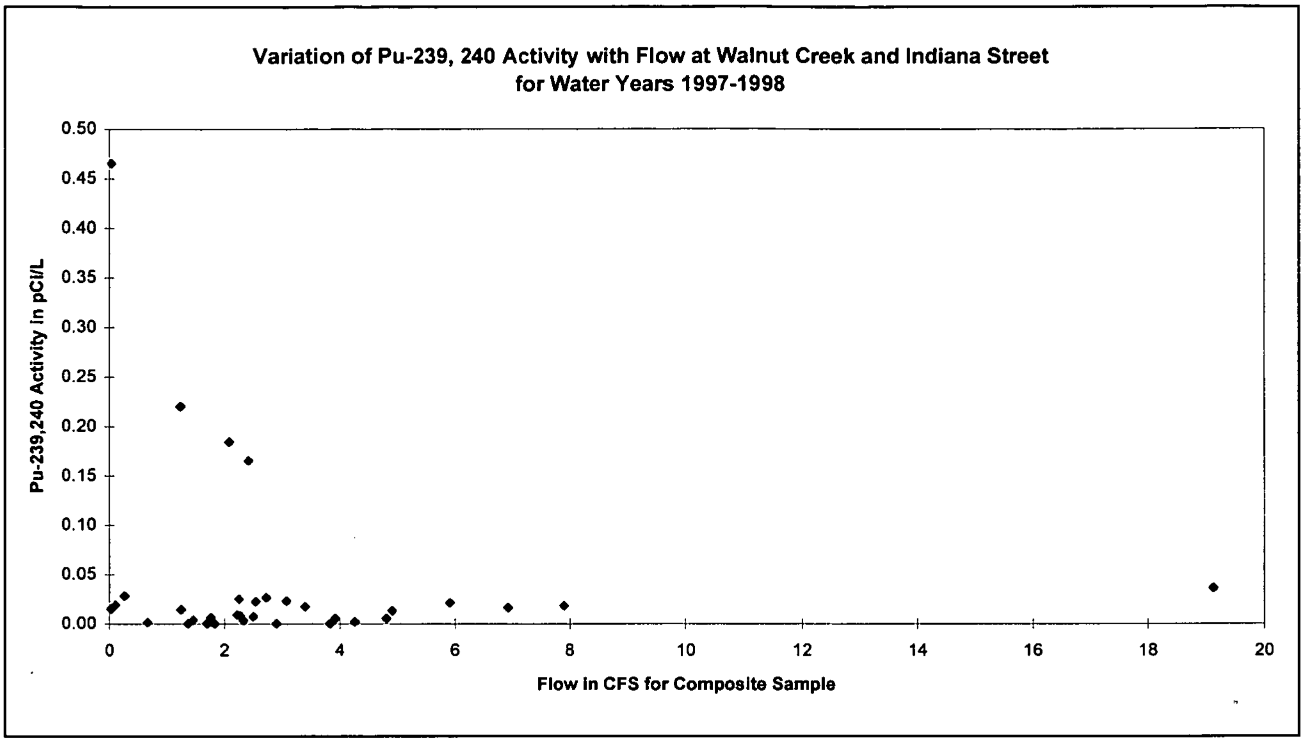


Figure 3-14. Variation of Pu Activity with Flow Rate at GS03.

4. GS03 SOURCE LOCATION ANALYSIS: HYPOTHESES AND CONCLUSIONS

In the previous Progress Reports, a discussion of possible source hypotheses was included. The following section in this Progress Report #3, includes those hypotheses which are still considered possible causes of the elevated measurements at GS03. In the following section, a discussion of source hypotheses is presented. To date, a singular source for GS03 has not be identified. Information collected to date does not point to any singular conclusion. In fact, it is entirely possible that multiple sources and transport mechanisms are responsible for the elevated activities at GS03.

4.1. WIDESPREAD OR LOCALIZED SOIL AND SEDIMENT CONTAMINATION IN GS03 DRAINAGE

Site soils have a long history of contamination from historical releases. The section on historical releases (Section 3.7 in Progress Report #1) had identified numerous events from the Site's production era which introduced radioisotopes to Site drainages both as airborne and in surface-water runoff. Historic reports, the OU6 report, and a review of existing soil/sediment data indicate relatively low level, widespread Pu contamination of soils and sediments throughout the Walnut Creek drainage. Airborne contamination would result in more distributed contamination, with levels diminishing further from sources such as the 903 Pad. The movement of contaminated stream sediments could result in localized contaminated deposits or more evenly distributed contamination, depending on how active natural erosion processes are in Walnut Creek. The evaluation of historic soil and sediment data reconfirmed the low level soil and sediment Pu contamination through out the Walnut Creek drainage. However, no anomalous Pu source areas (i.e., those well in excess of background) were evident within the tributary areas to GS03.

The OU6 report acknowledged that past production mission activities from 1952 through 1973 resulted in the release of significant amounts of Pu-contaminated surface waters to North and South Walnut Creeks, tributary to GS03. The B-Series pond reconstruction efforts from 1971 through 1973 were estimated to have re-mobilized several curies of Pu contaminated sediments, most of which would have been re-deposited in Pond B-1. Unknown amounts would have continued downstream and been deposited along South Walnut Creek, and subsequently Walnut Creek. As the drainage evolves over time, contaminated sediments could be buried, and then re-exposed at some later date. These deposits may be re-mobilized during periods of high flows which can erode stream bed and banks. These mobile contaminated deposits could then move through the drainage, and eventually be 'flushed' from the system, as the localized deposit of contaminated sediments is exhausted. Therefore, legacy contamination in the form of stream sediments could affect water quality intermittently, as indicated by the intermittent activities seen in GS03 samples (discussed in Section 3, Progress Report #1).

Soil and sediment activities for samples in the drainage are generally below 2 pCi/g. Activities in nearby non-tributary areas have been measured at up to 7 pCi/g. If an average activity of 2 pCi/g is assumed, and with a TSS in surface water of 100 mg/l (GS03 typically shows lower TSS values; other Site locations often show >1,000 mg/L), the expected activity would be 0.2 pCi/L. Given the soil activities in the drainage, the recent elevated activities at GS03 are possible.

Recent Walnut Creek sediment sample results from August 21, 1997 also show activities in this range of 0.0 to 1.0 pCi/g Pu (see Section 3.3 and Figure 3-20 in Progress Report #2). The arithmetic activity for these samples was 0.27 pCi/g, with a maximum of 2.32 pCi/g.

Although wide-spread low level contamination is acknowledged for soils within the Walnut Creek drainage basin, the pond discharge conditions under which elevated Pu values observed at GS03 for which no precipitation occurred, are inconsistent with the theory of overland flow as the source of contamination. However, it is possible that soils are eroded, moved by overland flow, and re-deposited in the stream bed with each passing storm runoff event. Additionally, it is possible that certain soil fractions most associated with Pu are preferentially suspended in surface water (perhaps due to size or density) and subsequently deposited through settling in areas of lower flow velocities. This physical fractionation could result in sediments with locally higher Pu activities. These deposited sediments could then be re-suspended by baseflow to provide significant Pu activity in diminished water volumes (i.e., not diluted by storm runoff).

As noted in Section 3.2.3 of Progress Report #1, samples collected during A-4 discharges that showed additional runoff from precipitation, which is indicative of overland flow, showed normal activities (0.022, 0.007 pCi/L). If runoff response from overland flow could be measured at GS03, then it is expected that any associated contaminated sediments would be available for sampling. Similarly, high runoff during the period April 24 through 29, 1997 (up to approximately 45 cubic feet per second at GS03), showed low levels of Pu.

4.2. TRIBUTARY SURFACE-WATER SOURCE

Another hypothesis to address is that radionuclide contamination of surface water observed at GS03 originated from surface-water tributaries to the Walnut Creek drainage. Two noteworthy tributaries, McKay Ditch and No Name Gulch, converge with Walnut Creek between the Terminal Ponds and GS03.

Several facts suggest that contaminated water sampled at GS03 did not originate as contaminated water in McKay Ditch and No Name Gulch. First, the high Pu activity recorded from the composite sample started on May 15, 1997 was collected during conditions of low flows. The flow rates observed at GS03 during collection of this sample (on the order of hundredths of a cfs) were likely much greater than any flow rates in the contributing tributaries. Further, No Name Gulch has a detention pond (possibly an old agricultural reservoir), which detains some runoff in No Name Gulch, dramatically increasing the amount of precipitation required to produce flows reaching Walnut Creek. Second, two composite samples collected at GS03 showed elevated levels of Pu, despite the fact that there was no significant precipitation during the sampling period to produce runoff in the major tributaries. Finally, composite samples taken at GS03, encompassing the significant runoff event of April 25 through 29, 1997 yielded no elevated radionuclide activities. Peak flow rates reached approximately 45 cubic feet per second at GS03 during the period April 24 through 29, 1997, indicating that tributaries likely contributed high flows correspondingly. If surface water from McKay Ditch and No Name Gulch were carrying activity to GS03, it would be expected that levels of activity would correlate with runoff.

Though there is significant evidence to suggest that the contaminated water observed at GS03 did not originate as contaminated water in the major tributaries, it remains possible that the tributaries contribute contamination in the form of solids to the Walnut Creek drainage. However, results from the August 21, 1997 sediment sampling along Walnut Creek (see Section 3.3 in Progress Report #2) do not indicate significant spatial trends in sediment activity that show contaminated sediment loads from these tributaries. Also, two new Source Location monitoring stations were installed on these tributaries just upstream from their confluences with Walnut Creek (GS33 on No Name Gulch and GS35 on the McKay Ditch; Figure 2-3). These locations are equipped to collect continuous flow-paced composite samples and gage stream flow which will be used in loading calculations. To date, both GS33 and GS35 have collected two samples.

Additionally, GS34 will be installed on Walnut Creek just upstream of the McKay Ditch confluence to provide increased loading resolution (see Section 10.2.3).

4.3. 'HOT PARTICLES'

It is possible that the recent elevated measurements at GS03 are an indication of the existing variability of actinide in surface water. Previous sampling protocols may not have accurately characterized the true variability of surface-water activities. Current sampling protocols (see discussion in Section 6.2.4 in Progress Report #1) have dramatically increased the number of grab samples collected at GS03.

The change in sampling protocol brings into question whether the recent 'elevated' measurements at GS03 and GS10 are actually deviations from the norm. In previous years, perhaps 50-100 grabs were pulled at these locations. Under the continuous flow-paced protocols, up to 2,500 grabs may be pulled in a given year depending on location (1,267 grabs were collected at GS03 in WY97). Assuming that activities in surface water are highly variable, due to either 'hot particles' or some other physiochemical mechanism, then an increased number of grabs would increase the probability of collecting water with relatively high activities. Consultation with the Actinide Migration Study Specialist and the DQO Statisticians is in progress regarding these sampling protocol effects. Results and analysis will be made available in subsequent reports.

4.4. POTENTIAL ISSUES WITH LABORATORY RESULTS

Another hypothesis concerns possible issues with the quality of analytical laboratory results received from GS03 as well as other RFCA locations. Variations in analytical data from what has been historically observed at GS03 could be attributed to many factors. These include changes in sample collection protocols (flow paced composites vs. grabs as previously described), use of many newly sub-contracted analytical labs (to date, three sub-contracted labs have been used versus one onsite lab) and general analytical variability for radiochemistry samples at or near the level of detection. All sub-contracted labs are required to perform to the same Statement of Work (SOW) and should produce the same quality data. This is one of the more likely sources of sample result variability as each laboratory used may introduce it's own variability within the radiochemistry analysis process.

These issues will continue to be investigated and if additional information is encountered, updates will be provided in subsequent reports.

5. DATA SUMMARY AND ANALYSIS FOR GS10

5.1. AUTOMATED SURFACE-WATER MONITORING DATA

Since the publication of Progress Report #2, results for only one additional sample have been returned from the labs (included in Table 5-1). Therefore, a complete update of the automated monitoring data analysis and the accompanying loading calculations is not included in this Progress Report #3. Complete updates and analysis will be included in the Final Evaluation Report on April 15, 1998.

Table 5-1. Detail for WY97 - WY98 Continuous Flow-Paced Composite Samples at GS10.

Sample Start Time	Sample End Time	Discharge Volume During Sample (cubic feet)	Pu-239, 240 Activity (pCi/L)	Pu-239, 240 Load (micrograms)
10/1/96 11:24	10/16/96 13:51	68375[a]	0.032	0.87
10/16/96 13:51	10/31/96 9:13	93846	0.077	2.88
10/31/96 9:13	11/11/96 23:57	49095	0.0295	0.58
11/11/96 23:57	11/20/96 15:13	74221	0.037	1.10
11/20/96 15:13	12/3/96 15:52	79418	0.057	1.81
12/3/96 15:52	12/20/96 15:15	67745	0.064	1.73
12/20/96 15:15	1/3/97 14:25	61756	0.027	0.67
1/3/97 14:25	2/5/97 16:37	152467	0.074	4.50
2/5/97 16:37	**2/18/97 14:37**	**63597**	**0.16**	**4.06**
2/18/97 14:37	**2/24/97 15:51**	**84912**	**0.17**	**5.76**
2/24/97 15:51	3/5/97 14:51	87008	0.025	0.87
3/5/97 14:51	3/17/97 11:06	71098	0.054	1.53
3/17/97 11:06	3/28/97 9:13	86086	0.12	4.12
3/28/97 9:13	**4/2/97 16:10**	**38549**	**0.3**	**4.61**
4/2/97 16:10	**4/11/97 13:56**	**182496**	**0.15**	**10.92**
4/11/97 13:56	**4/24/97 8:56**	**328065**	**0.41**	**53.65**
4/24/97 8:56	4/25/97 12:59	213488	0.086	7.32
4/25/97 12:59	4/26/97 17:02	321887	0.07	8.99
4/26/97 17:02	5/12/97 16:01	360457	0.086	12.37
5/12/97 16:01	**5/25/97 15:48**	**158561**	**0.38**	**24.03**
5/25/97 15:48	6/8/97 13:53	221434	0.134	11.84
6/8/97 13:53	6/12/97 10:05	42200	0.056	0.94
6/12/97 10:05	6/16/97 8:06	61625	0.088	2.16
6/16/97 8:06	6/23/97 7:35	47979	0.005	0.10
6/23/97 7:35	**6/30/97 13:24**	**48441**	**0.274**	**5.29**
6/30/97 13:24	7/8/97 7:49	46557	0.056	1.04
7/8/97 7:49	7/16/97 15:24	56555	0.028	0.63
7/16/97 15:24	7/23/97 15:41	55268	0.026	0.57
7/23/97 15:41	7/31/97 9:09	263898	0.107	11.26
7/31/97 9:09	**8/4/97 17:25**	**158668**	**1.46**	**92.40**
8/4/97 17:25	**8/6/97 7:55**	**300046**	**1.91**	**228.60**
8/6/97 7:55	9/1/97 9:14	457693	0.07	12.78
9/1/97 9:14	9/18/97 10:27	101433	0.077	3.12
9/18/97 10:27	**9/23/97 16:55**	**230406**	**0.427**	**39.24**
9/23/97 16:55	10/2/97 11:44	71022	0.104	2.95

Elevated samples above the action level are indicated in bold.
[a] Discharge volume calculated from 10/1/96 0:00 for loading purposes.

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6. GS10 SOURCE LOCATION ANALYSIS: HYPOTHESES AND CONCLUSIONS

In the following section, a discussion of source hypotheses for GS10 is presented. To date, a singular source for GS10 can not be identified. Information collected to date does not point to any singular conclusion. In fact, it is likely that multiple sources and transport mechanisms are responsible for the elevated activities at GS10.

6.1. WIDESPREAD OR LOCALIZED SOIL AND SEDIMENT CONTAMINATION IN GS10 DRAINAGE

Site sediments have a long history of contamination from historical releases. The section on historical releases (see Section 4.7 in Progress Report #2) identifies numerous events from the Site's production era which introduced radioisotopes to Site drainages both as airborne and in surface-water runoff. In Section 4 of Progress Report #2, historic reports and a review of existing soil/sediment data indicate widespread Pu contamination of soils and sediments throughout the GS10 drainage. Airborne contamination would result in more distributed contamination, with levels diminishing further from sources such as the 903 Pad. The movement of contaminated soils and sediments in runoff could result in localized contaminated deposits or more evenly distributed contamination, depending on how active natural erosion processes are in the GS10 drainage. The GS10 drainage includes numerous Pu source areas.

Soil and sediment activities for samples in the drainage show a range of 0.0 to more than 4,000 pCi/g (see Section 4.6 of Progress Report #2). The highest values are associated with soils under the 903 Pad, and therefore do not come in contact with runoff. The maximum TSS measured to date at GS10 is 1,500 mg/L. At these levels of TSS and assuming uniform suspension of soils, a soil with 0.1 pCi/g could yield activities of 0.15 pCi/L. Given the soil activities in the drainage, the recent elevated activities at GS10 are possible.

Section 4.2 of Progress Report #2 shows that the GS10 sub-basins which are currently monitored all contribute Pu load to GS10, further supporting the hypothesis of multiple or widespread source areas. Additionally, the apparent relationship between TSS, precipitation, and Pu activity supports this hypothesis. It is also possible that soils are eroded, moved by overland flow, and re-deposited in ditches with each passing storm runoff event. Additionally, it is possible that certain soil fractions most associated with Pu are preferentially suspended in surface water (perhaps due to size or density) and subsequently deposited through settling in areas of lower flow velocities. This physical fractionation could result in sediments with locally higher Pu activities. These deposited sediments could then be re-suspended by subsequent events to provide Pu activity at GS10.

Data collected from the Source Location monitoring locations (see Section 10.2.3) will further determine the proportions of Pu load that each monitored sub-basin may be contributing. If a certain sub-basin is determined to be contributing a significant proportion of the load at GS10, watershed improvements can be used to mitigate further transport. These types of watershed improvements have been demonstrated for other locations around the Site, specifically at GS27 (see Sections 4.2 and 4.3 of Progress Report #2).

6.2. LOCALIZED CONTAMINATION NEAR GS10 SAMPLING LOCATION

The Historical Release Report supports the hypothesis that localized contamination exists in the drainage immediately upstream of GS10, specifically the sediments in the stream reach between B991 and GS10. The area was identified in the Historical Release Report due to past radioactive releases to the B-series drainages (as discussed in Section 4.7 of Progress Report #2), and the soil in the area is potentially contaminated with radionuclides.

Data collected from the Source Location monitoring locations (see Section 10.2.3) will further determine the proportions of Pu load that each monitored sub-basins may be contributing. If the sub-basins upstream from these areas (around B991 and 995) are shown to be contributing a small proportion of the load at GS10, then this area may be contributing a significant proportion of the load. Sediment samples could then be collected to evaluate the sediments in this stream reach.

6.3. TRIBUTARY SURFACE-WATER SOURCE

Another hypothesis to address is that radionuclide contamination of surface water observed at GS10 originated from surface water tributary to GS10. Section 4.2 of Progress Report #2 shows that the GS10 sub-basins which are currently monitored all contribute Pu load to GS10, supporting the hypothesis that tributary surface water is carrying load toward GS10. Data collected from the Source Location monitoring locations (see Section 10.2.3) will further determine the proportions of surface-water Pu load that each monitored sub-basin may be contributing. If a certain sub-basin is determined to be contributing a significant proportion of the load at GS10, watershed improvements can be used to mitigate further transport in surface water. These types of watershed improvements have been demonstrated for other locations around the Site, specifically at GS27 (see Section 4.2 of Progress Report #2). A more thorough analysis of watershed improvements is included in Section 9.

7. DATA SUMMARY AND ANALYSIS FOR SW093

7.1. AUTOMATED SURFACE-WATER MONITORING DATA

7.1.1. Data Summary

Three automated gaging stations exist in the SW093 drainage: SW093, SW118, and GS32. Locations are given in Figure 7-1. Significant data exists for flow and radionuclide activities at SW093. Information for TSS, metals, major ions, etc. is more limited. Additional information for these parameters will need to be collected if needed. Individual results are averages of target, duplicate, and replicate results for each sample. Validated results which were rejected are not included. All activities are for total radionuclides.

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Reliable flow record has been collected at SW118 since March 1996. Water-quality information at SW118 is very limited, therefore loading with SW118 will not be provided in this Progress Report. SW118 has recently been upgraded with sampling equipment to become a Source Location monitoring station. Future water-quality information will be used to calculate load contributions to SW093. Future information collected at the other proposed Source Location stations tributary to SW093 (see Section 10.2.3) will also be used for load calculations. This information will be presented in the Final Report on April 15, 1998.

Performance Monitoring location GS32 has been collecting samples since April 1997, and four samples have been analyzed to date. Load contributions to SW093 will be calculated when more analytical results are available. Flow record can not be measured at this location. Consequently, discharge volumes will need to be estimated based on relative drainage basin area. This information will be presented in the Final Report on April 15, 1998.

Surface-Water Flow Rates and Discharge Volumes

A reliable flow record has been collected at SW093 since WY93, and since December 1995 at SW118. Flow data included in this Progress Report for these locations ends on September 30, 1997. Relative average annual discharge percent to SW093 from SW118 is 16%. Variation of flow rates and discharge volumes is significant at SW093, and coincides with variation in precipitation (as shown on Figure 7-2 and Figure 7-3). Baseflow at SW093 is nearly continuous year-round.

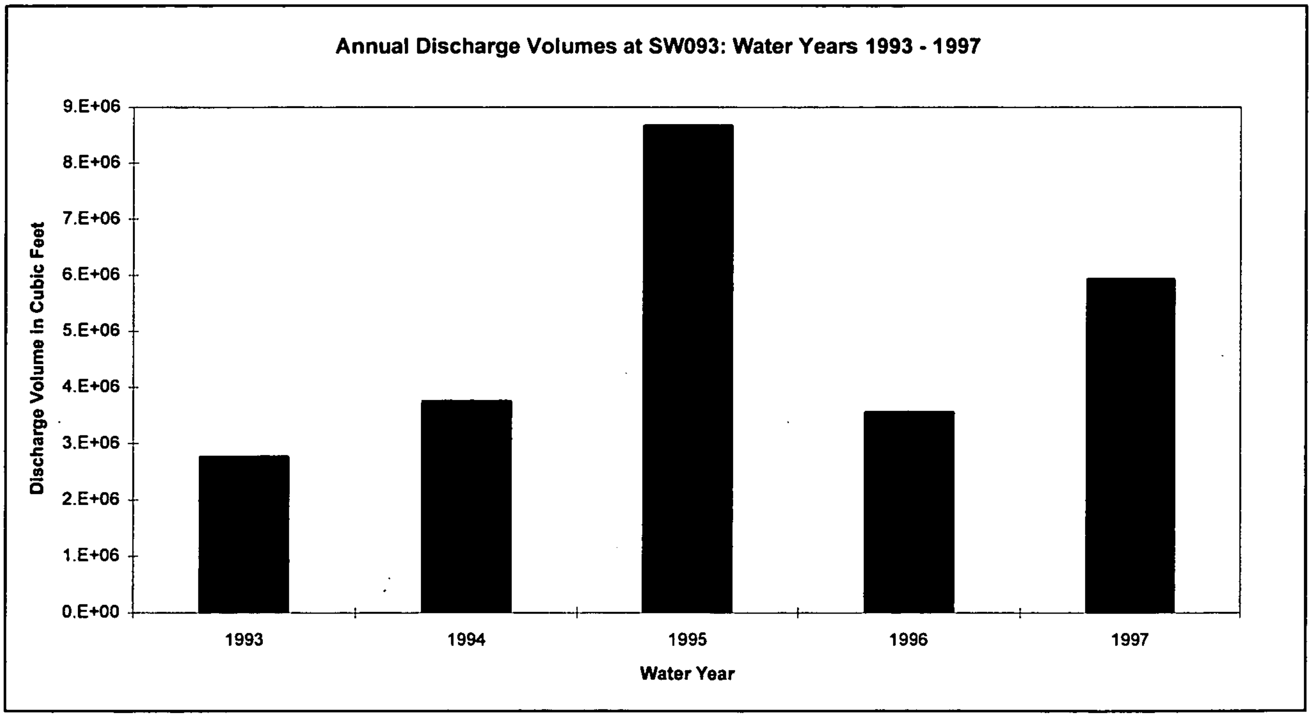


Figure 7-2. Annual Discharge Volumes for SW093.

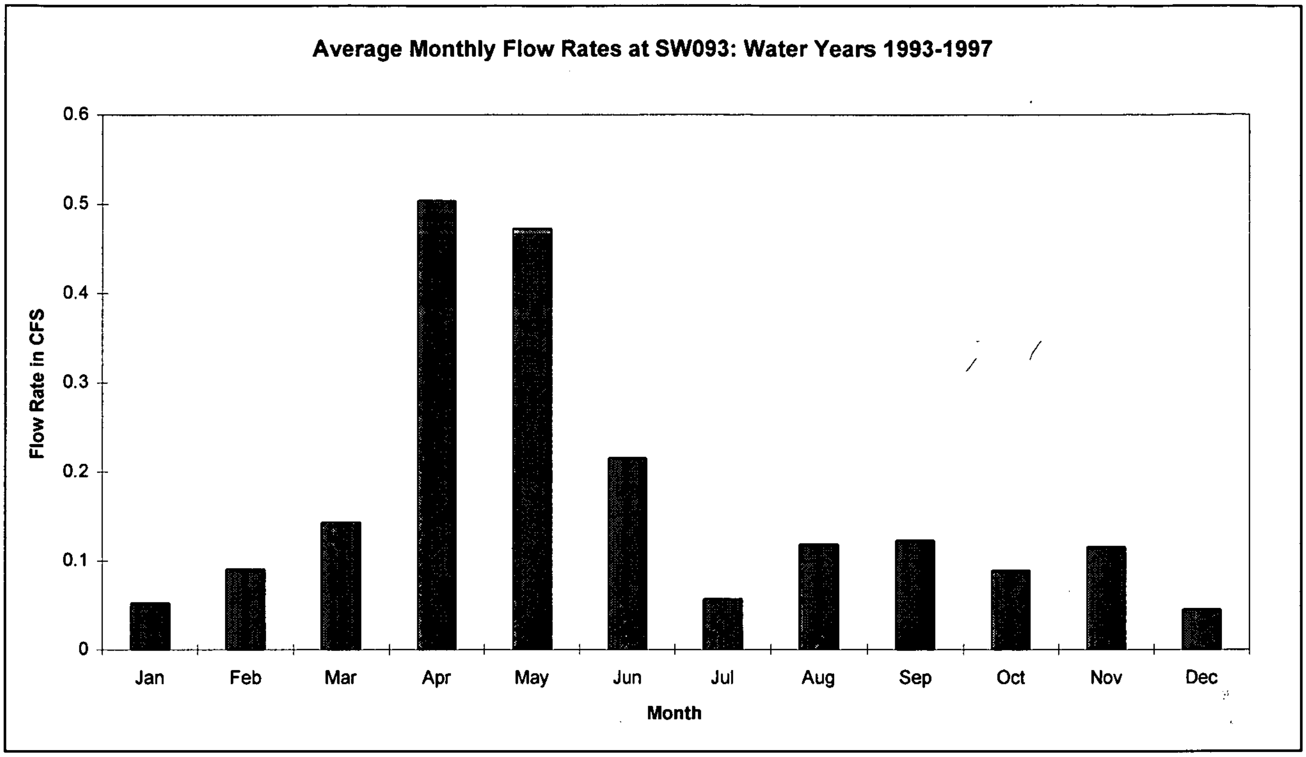


Figure 7-3. Average Monthly Flow Rates at SW093.

Radionuclide Activities

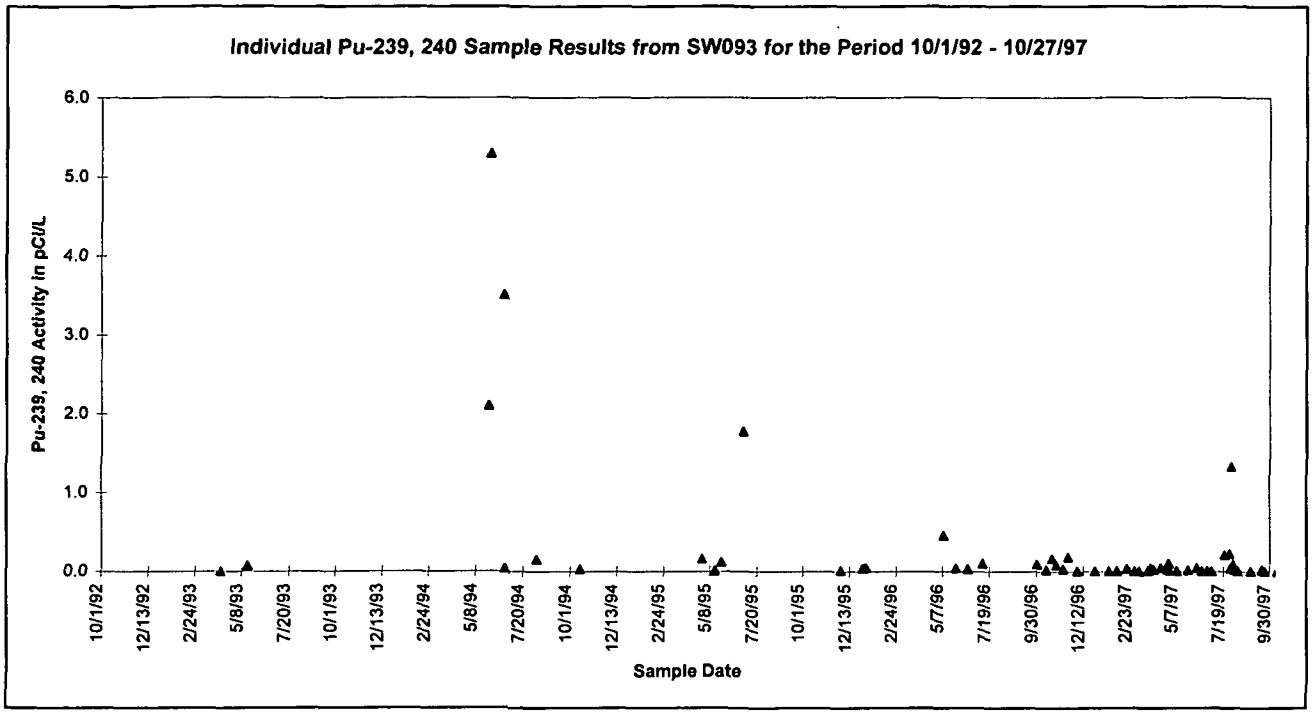
Individual analytical results for Pu at SW093 are shown in Figure 7-4. All sample results are plotted regardless of sampling protocol employed[11]. The large variation in activities is evident in these plots. This variation could be caused by variations in precipitation, some physiochemical or biological phenomena, some 'hot particle' mechanism, or a changing drainage basin. For example, similar precipitation events with similar runoff rates could give different activities if the precipitation was more intense on a localized source area. Regardless, it is apparent that transport of actinides in the environment and the associated variability is not fully understood. Summary statistics for these results are shown in Table 7-1. These activities are arithmetic averages, which do not take into account the hydrologic conditions during sampling (storm-event, baseflow, etc.), the flow rate (more importantly, the discharge volume), or the sampling protocol. The recent elevated results at SW093 (Figure 7-4) are from samples collected during large precipitation events during the period August 1 through August 4, 1997.

[11] Individual grabs, time-paced (scheduled grabs) composites, storm-event (hydrograph rising limb) flow-paced composites, and continuous flow-paced composites are shown. For a discussion of sample collection methods, see Section 6.2.4 in Progress Report #1.

Table 7-1. Summary Statistics for Samples from SW093.

Sampling Location	Number of Samples	Average[a] Activity (pCi/L)	Maximum Result (pCi/L)	Standard Deviation[b] (pCi/L)
WY93 - WY98	57	0.295	5.3	0.898

[a] Arithmetic average
[b] Assumes normal distribution

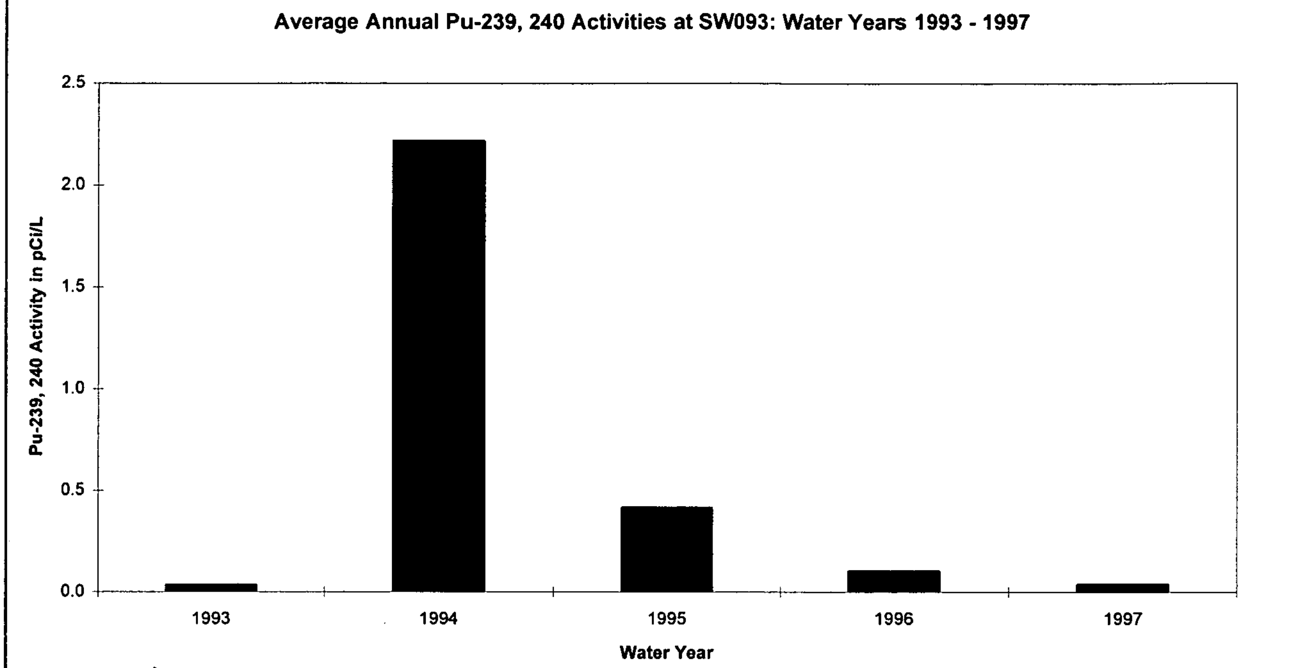


Results for composite sample collected 10/6 -10/13/97 have not been returned from lab.

Figure 7-4. Individual Analytical Pu Results for SW093.

Figure 7-5 shows the average annual activities at SW093 for WY93 - WY97. For WY93 - WY96, arithmetic averages are plotted. However, due to the continuous flow-paced sampling protocols currently in place, the more representative volume-weighted average activity is shown for WY97. This volume-weighted average is calculated in a fashion similar to 30-day averages[3], except that the period is from October 1, 1996 to September 30, 1997.[12] It is important to note that although elevated measurements were made this year, the volume-weighted average is comparable to the activities for other years.

[12] Each carboy has a load in pCi calculated from the activity and the associated creek discharge volume. The total load in pCi for all samples is then divided by the total creek discharge volume to give the volume-weighted activity in pCi/L.



Volume-weighted WY97 average is plotted.

Figure 7-5. Average Annual Pu Activities for SW093.

It is generally agreed that Pu tends to form strong associations with particulate matter (see Section 9.1 for references). If contaminated particles are transported in surface water, then the observed Pu levels could be correlated with the amount of TSS. The data collected at SW093 does not show a strong correlation (Figure 7-6), but an upward trend is noted. During high intensity precipitation events, with increased raindrop impact, higher quantities of solids are transported in overland flow. Similarly, higher flow rates in ditches and creeks generally result in increased TSS values due to higher flow velocity and turbulence. Figure 7-7 shows monthly arithmetic average activities which increase for months with higher rainfall and flow rates which are shown on Figure 7-3. The elevated activities for the month of August are likely a result the recent intense monsoon-related precipitation during July 30 through August 6, 1997.

7.1.2. Loading Analysis

WY93 - WY97 Monitoring Data

Annual loads for SW093 in micrograms are plotted in Figure 7-8. For WY93 - WY96, the arithmetic average activity is multiplied by the associated total annual discharge volume, then converted to micrograms. For WY97, the volume-weighted activity for the year multiplied by the associated discharge volume, then converted to micrograms.

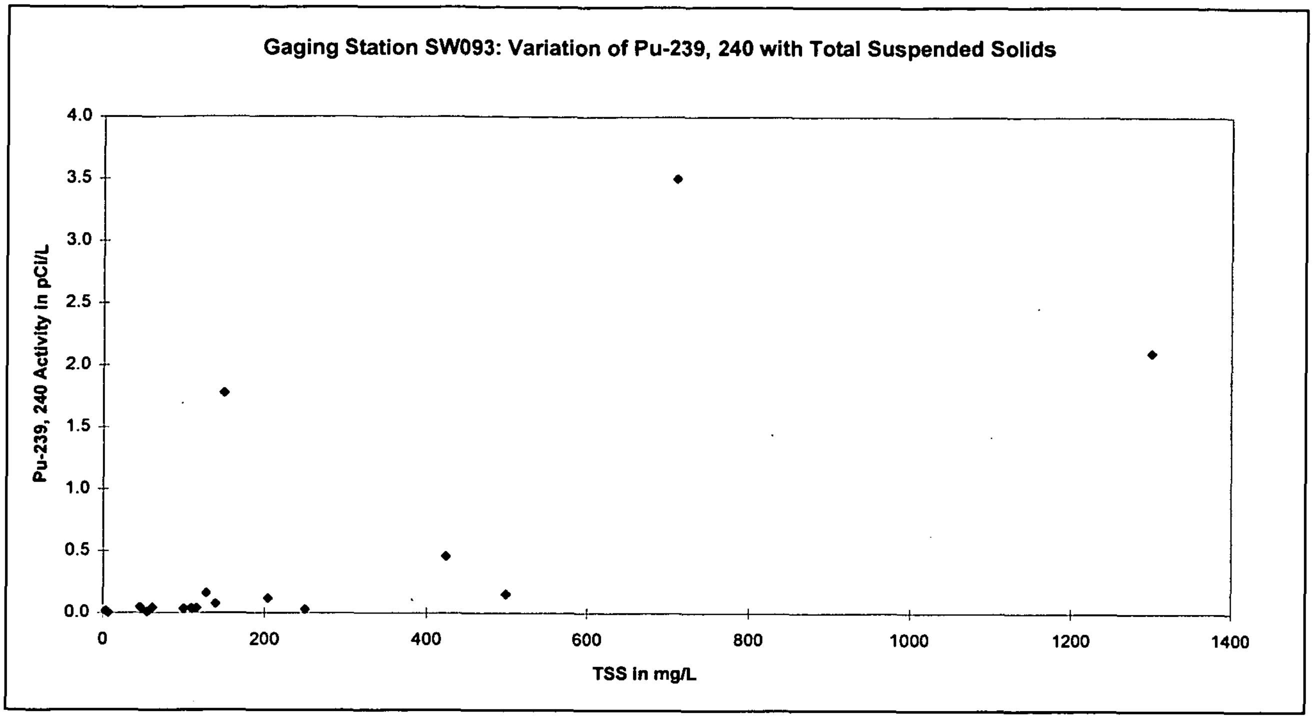
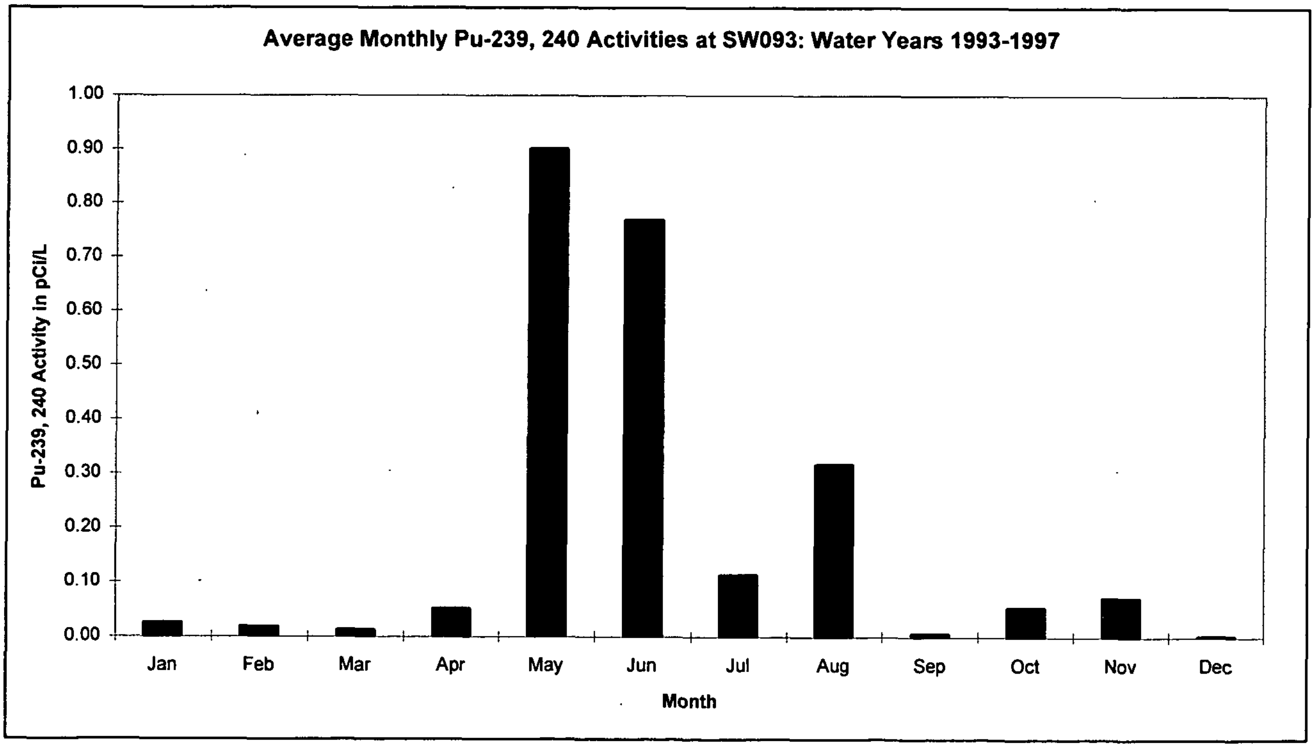


Figure 7-6. Variation of Pu with TSS at SW093.



All averages are arithmetic.

Figure 7-7. Average Monthly Pu Activities at SW093.

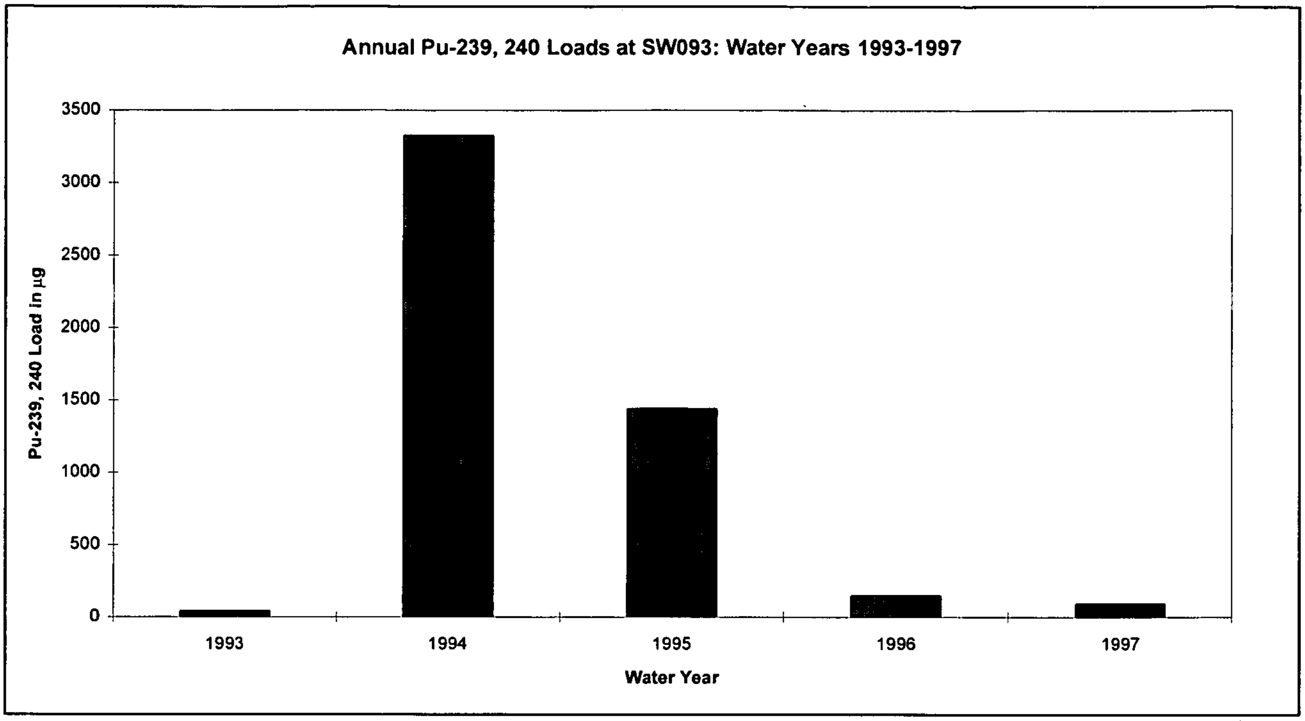


Figure 7-8. Annual Pu Loads at SW093.

WY97 Continuous Flow-Paced Monitoring Data

Figure 7-9 shows volume-weighted average monthly activities for continuous flow-paced samples collected in WY97 at SW093. Analytical results are available through October 5, 1997.

Detail for each continuous flow-paced composite sample for WY97 at SW093 is presented in Table 7-2. Elevated samples are indicated in bold. It is important to note the variable activity for the samples. It is apparent that the variability of surface-water activity and the transport mechanisms for Pu are not fully understood. Variations in intensity of precipitation events, with increased raindrop impact, could result in varying quantities of solids transported in overland flow. Similarly, variable flow rates in ditches and creeks generally result in variable TSS values due to varying flow velocities and turbulence. Additionally, seasonal changes in biological and chemical processes may influence Pu transport.

Prior to WY97, SW093 collected flow-paced storm-event samples. During WY97, continuous flow-paced sampling protocols were implemented. When comparing the SW093 protocols, the WY97 volume-weighted average is 0.039 pCi/L Pu, while the WY93-WY96 arithmetic average of storm-event samples was 0.734 pCi/L Pu. It is not clear if this change in activity can be attributed to overall improvement in water-quality and/or the change in sampling protocols at SW093. For a discussion of the sampling protocol changes see Section 6.2.4 in Progress Report #1.

Table 7-2. Detail for WY97 Continuous Flow-Paced Composite Samples at SW093.

Sample Start Time	Sample End Time	Discharge Volume During Sample (cubic feet)	Pu-239, 240 Activity (pCi/L)	Pu-239, 240 Load (micrograms)
10/1/96 14:22[a]	10/15/96 22:15	64747	0.091	2.35
10/15/96 22:15	10/24/96 11:19	56718	0.018	0.41
10/24/96 11:19	10/31/96 18:24	61320	0.160	3.91
10/31/96 18:24	11/11/96 22:23	49156	0.077	1.51
11/11/96 22:23	11/19/96 19:06	71967	0.026	0.75
11/19/96 19:06	12/3/96 15:23	89457	0.179	6.39
12/3/96 15:23	12/16/96 13:26	59800	0.002	0.05
12/16/96 13:26	12/30; NSQ[b]	80351	0.039	1.25
12/30/96 13:00	1/21/97 10:37	96263	0.004	0.15
1/21/97 10:37	2/3/97 15:29	60558	0.003	0.07
2/3/97 15:29	2/18/97 14:11	76933	0.004	0.12
2/18/97 14:11	2/28/97 14:02	178825	0.033	2.35
2/28/97 14:02	3/10/97 16:13	172866	0.004	0.28
3/10/97 16:13	3/24/97 10:46	104459	0.001	0.04
3/24/97 10:46	3/28/97 10:17	49254	0.008	0.16
3/28/97 10:17	4/2/97 15:43	43413	0.038	0.66
4/2/97 15:43	4/11/97 14:13	243775	0.025	2.43
4/11/97 14:13	4/24/97 9:14	448437	0.042	7.51
4/24/97 9:14	4/25/97 13:16	262160	0.027	2.82
4/25/97 13:16	4/26/97 17:18	409142	0.100	16.32
4/26/97 17:18	5/7/97 11:28	730191	0.015	4.37
5/7/97 11:28	5/25/97 15:39	289800	0.009	1.04
5/25/97 15:39	6/8/97 14:05	251479	0.015	1.50
6/8/97 14:05	6/16/97 8:34	94573	0.044	1.66
6/16/97 8:34	6/24/97 7:56	51675	0.003	0.06
6/24/97 7:56	7/1/97 13:35	29543	0.004	0.05
7/1/97 13:35	7/21/97 15:42	36769	0.001	0.01
7/21/97 15:42	7/29/97 8:35	61095	0.208	5.07
7/29/97 8:35	7/30/97 18:01	104936	0.224	9.38
7/30/97 18:01	8/1/97 14:55	52602	0.037	0.78
8/1/97 14:55	**8/4/97 17:15**	**157997**	**1.330**	**83.82**
8/4/97 17:15	8/6/97 7:39	360821	0.085	12.23
8/6/97 7:39	8/12/97 10:16	375053	0.020	2.99
8/12/97 10:16	9/1/97 9:52	252990	0.002	0.20
9/1/97 9:52	9/18/97 10:15	104940	0.002	0.08
9/18/97 10:15	9/23/97 16:26	222439	0.018	1.60
9/23/97 16:26	10/6/97 16:41	114708	0.000	0.00

[a] Discharge volume calculated from 10/1/96 0:00 for loading purposes.

[b] Sample had insufficient volume for analysis, activity set to volume-weighted average to date for load calculation purposes.

Elevated samples above the action level are indicated in bold.

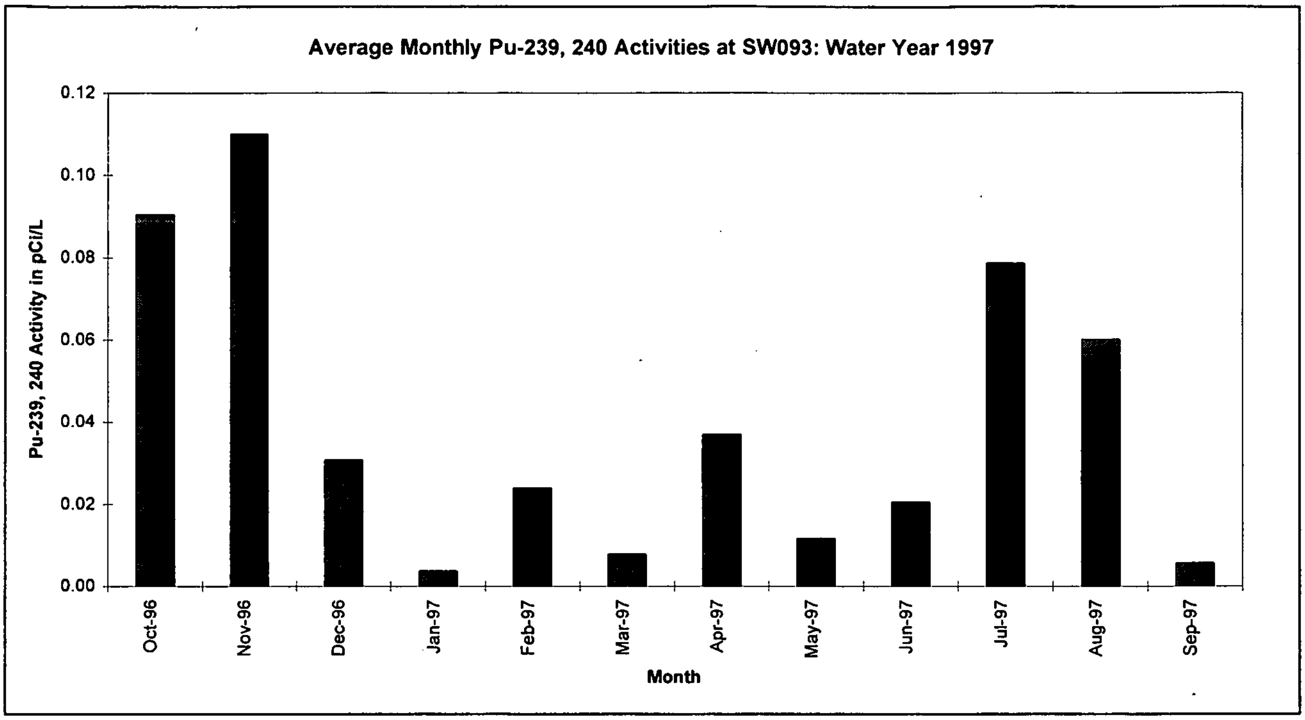


Figure 7-9. Average Monthly Pu Activities for WY97 at SW093.

7.1.3. Data Correlations

Flow Rates and Total Suspended Solids

As stated in Progress Report #2, Pu tends to form strong associations with particulate matter (as shown in Figure 4-17 in Progress Report #2 for GS10). If these particles are transported in surface water, then so is Pu. During high intensity precipitation events, with increased raindrop impact, higher quantities of solids are transported in overland flow. Similarly, higher flow rates in ditches and creeks, generally result in increased TSS values due to higher flow velocity and turbulence. Figure 7-10 indicates an upward trend in Pu activity with increasing TSS. Variation may be attributed to variable precipitation within the drainage which could fall on areas of differing contamination levels, or preferential association of Pu with specific particulate fractions based on physiochemical mechanisms. Precipitation runoff transporting soils from relatively contaminated areas could result in higher Pu to TSS ratios, and vice versa.

Figure 7-11 and Figure 7-12 show the variation of Pu activity with flow for SW093. The activity plotted is the analytical result for the sample; the flow is the average of the flow rates during each composite grab. An upward trend generally indicates the increased movement of Pu during higher flow rates. This can occur when the source is widespread (movement through overland flow and raindrop impact), or when the source exists in the streambed itself (movement through increased scouring). These are the mechanisms commonly seen at other Site monitoring locations. A downward trend may indicate that groundwater may be a source. For example, during low flow rates a contaminated groundwater source could make up the a larger proportion of the flow, and result in higher activities. If runoff that is relatively cleaner than the contaminated groundwater entered the creek, the groundwater source would be diluted, resulting in lower activities. Figure 7-11 and Figure 7-12 show the variation in Pu activity with flow rate at SW093. Variation could be caused by variations in precipitation, some physiochemical or biological phenomena, some 'hot particle' mechanism, radiochemical analyses by different subcontractor laboratories, or a changing drainage basin. For example, similar precipitation events with similar runoff rates could give different activities if the precipitation was more intense on a localized source area. Precipitation runoff transporting soils from relatively contaminated areas could result in higher Pu to flow ratios, and vice versa. Regardless, it is apparent that transport of actinides in the environment and the associated variability is not fully understood.

Real-Time Water-Quality Parameters: Turbidity, Nitrate, Specific Conductivity, and pH

Average turbidity, nitrate, specific conductivity, and pH for each composite sample collection period at SW093 were calculated by averaging the water quality readings corresponding to each grab sample time. Variation of Pu activity was plotted against the corresponding water-quality parameters. This data is presented in Figure 7-13, Figure 7-14, Figure 7-15, and Figure 7-16. No apparent relationships were observed between Pu and turbidity, nitrate, specific conductivity, or pH.

It should be noted that the lack of an apparent correlation between Pu and turbidity does not mean that Pu could not be correlated with solids as measured as TSS. TSS is a direct measurement of the mass of solids in suspension, whereas turbidity is a measure of the light scattering properties of solids in suspension as related to particle size and number.

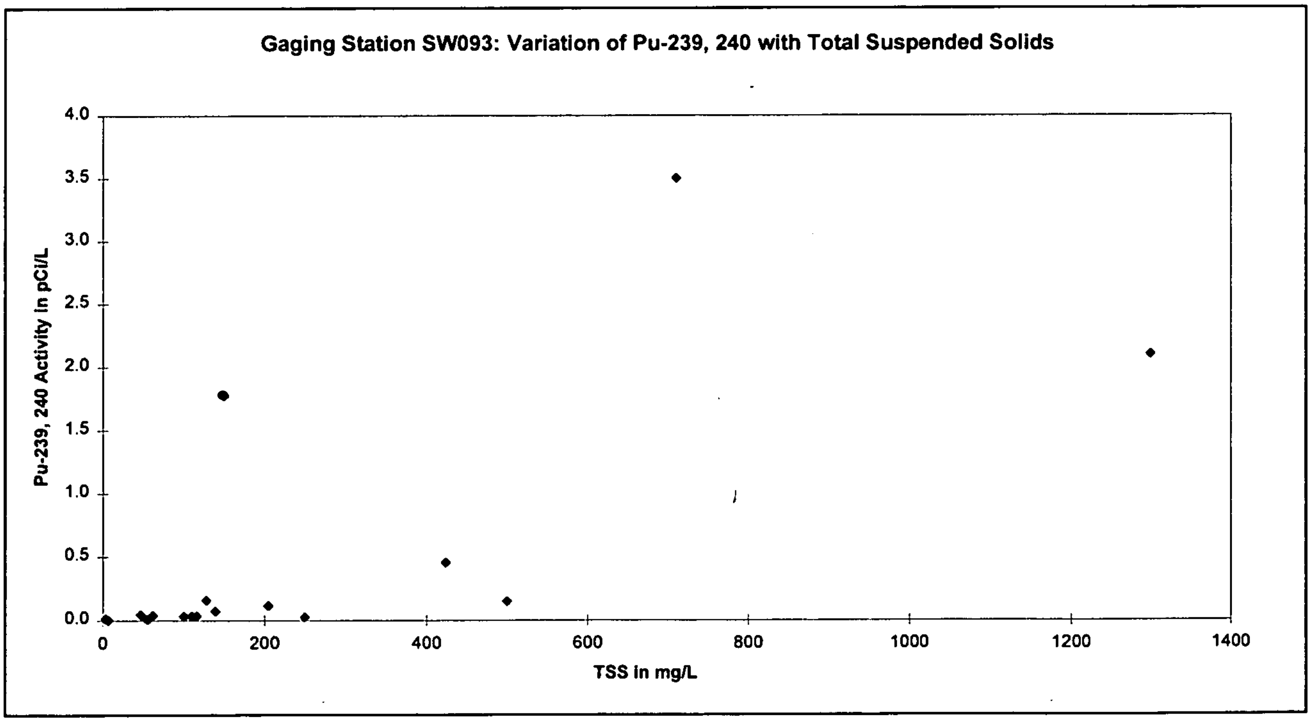


Figure 7-10. Variation of Pu with TSS at SW093.

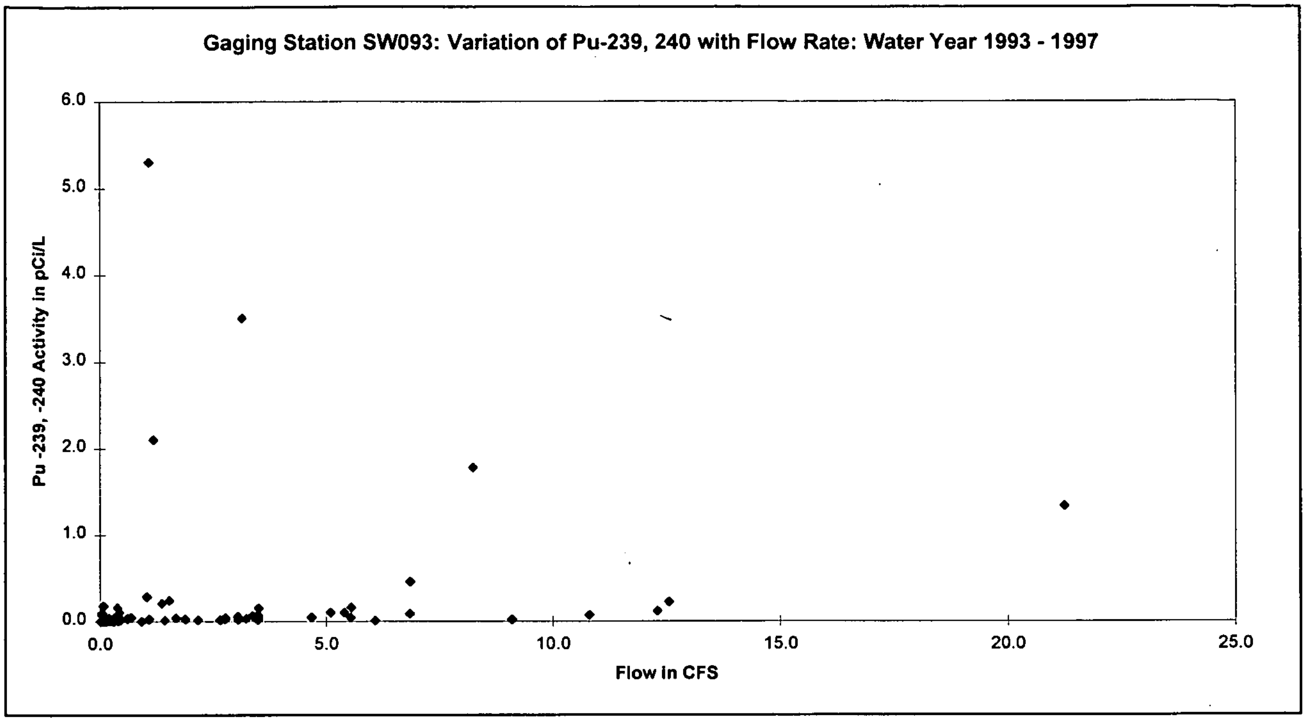


Figure 7-11. Variation of Pu Activity with Flow Rate at SW093: WY93 - WY97.

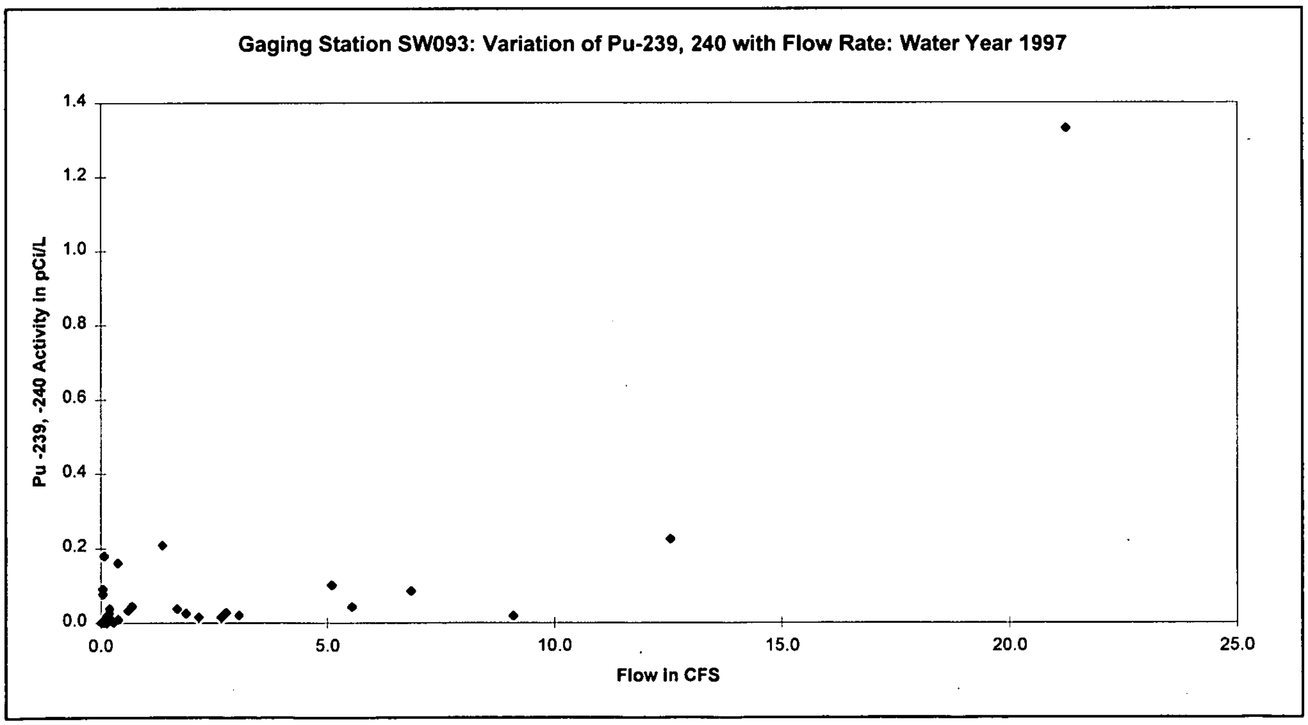


Figure 7-12. Variation of Pu Activity with Flow Rate at SW093: WY97.

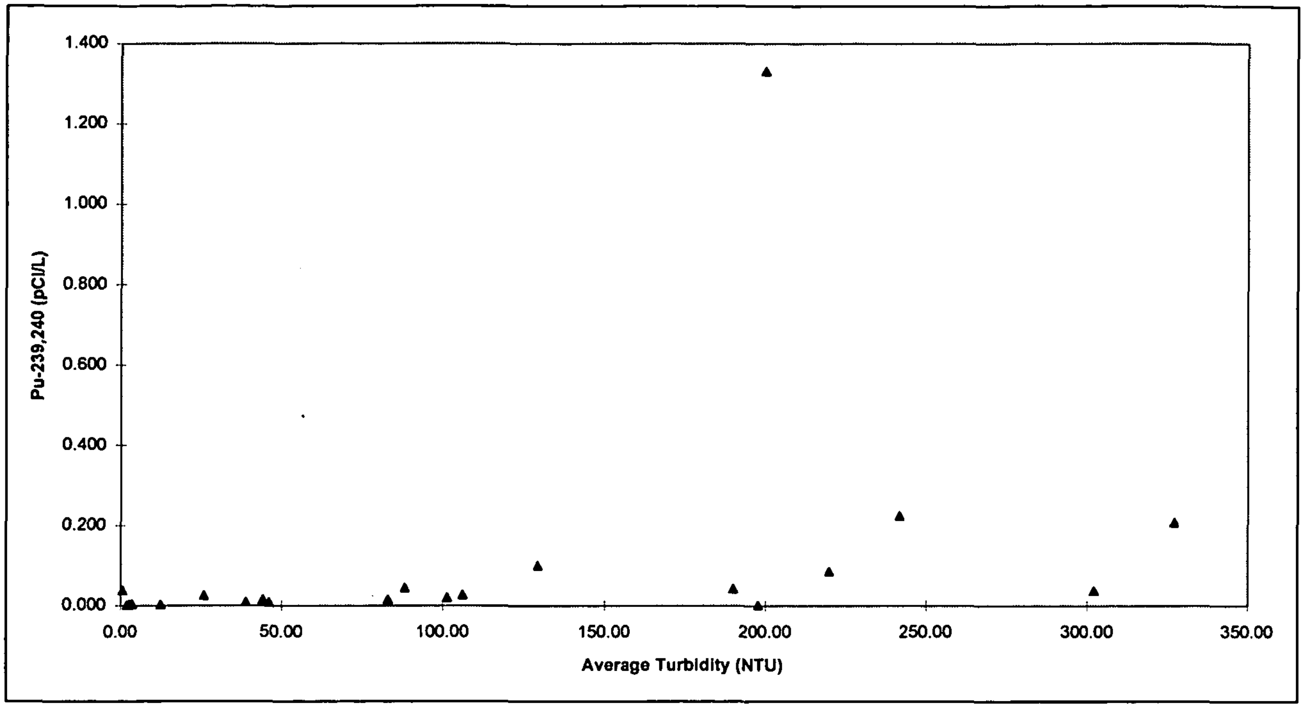


Figure 7-13. Variation of Pu Activity with Average Turbidity at SW093.

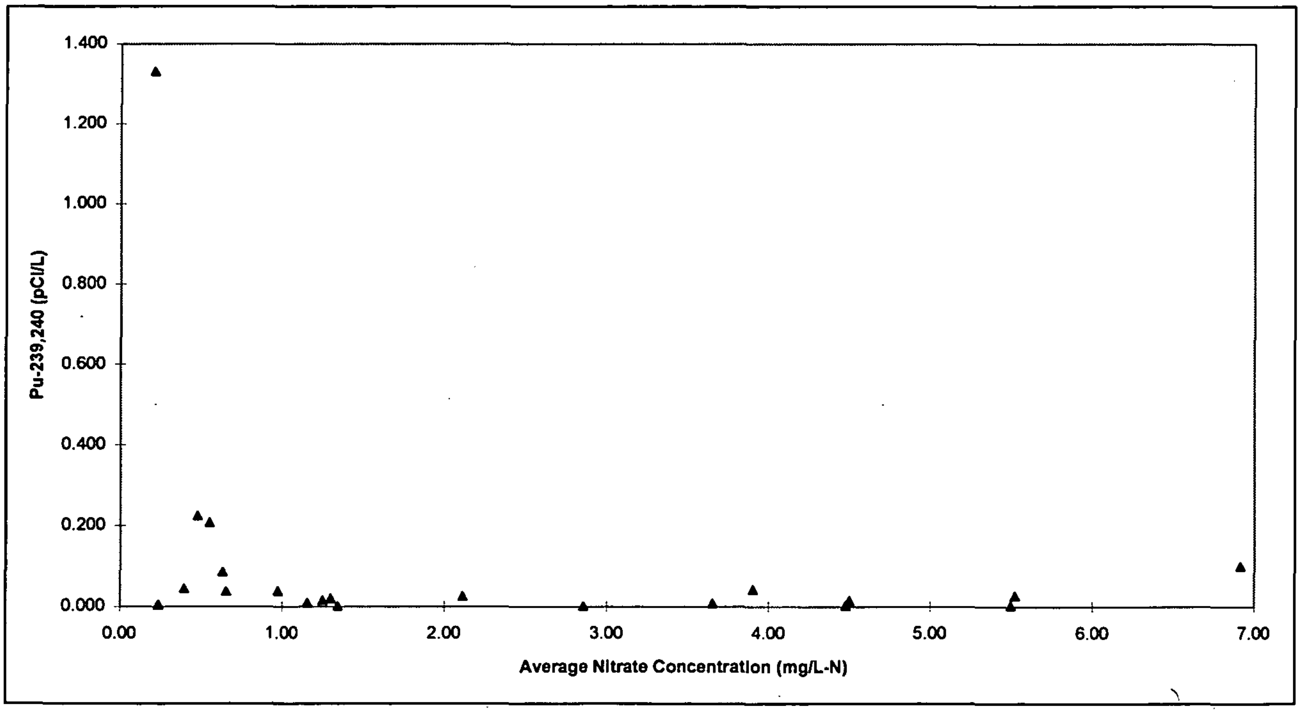


Figure 7-14. Variation of Pu Activity with Average Nitrate at SW093.

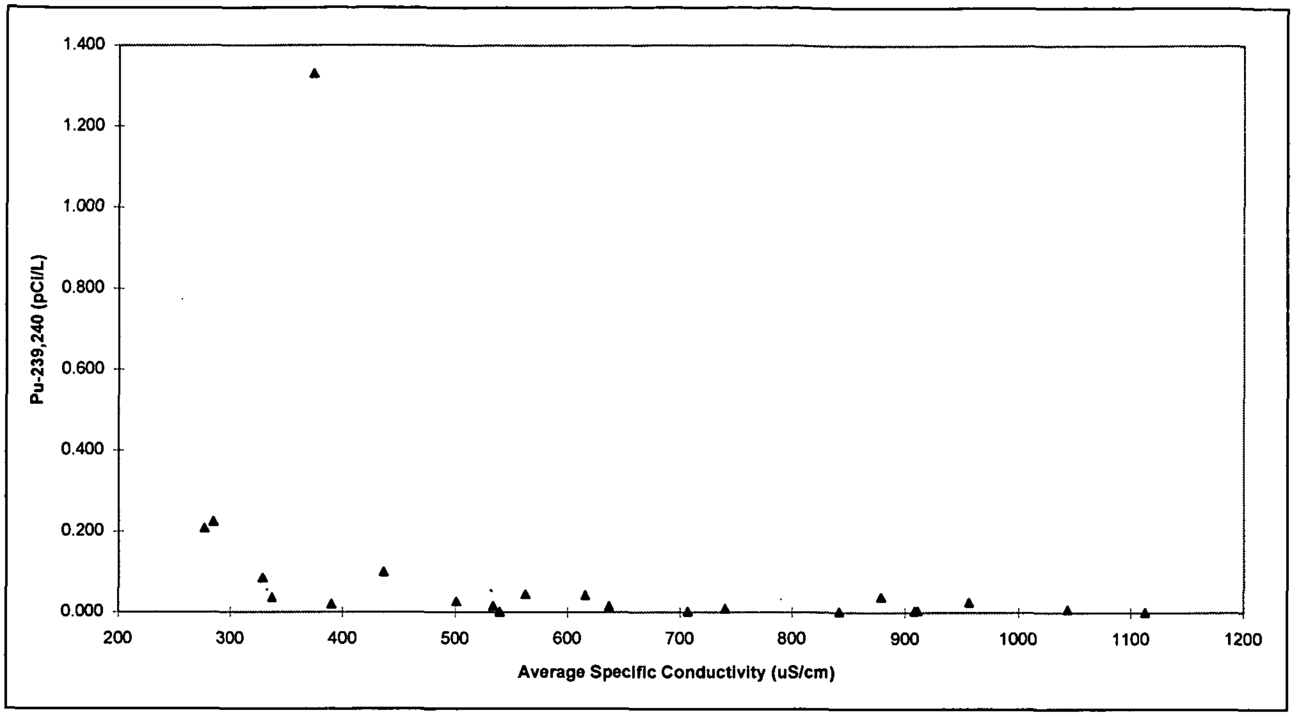


Figure 7-15. Variation of Pu Activity with Average Specific Conductivity at SW093.

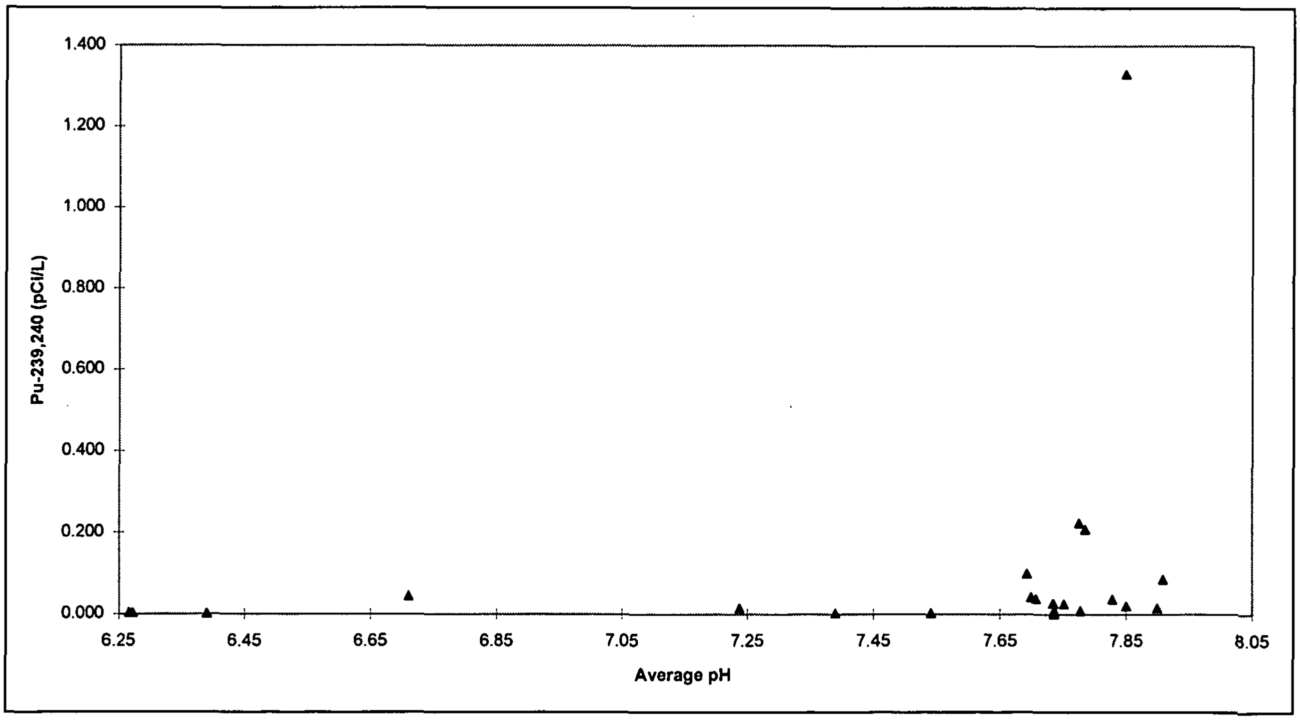


Figure 7-16. Variation of Pu Activity with Average pH at SW093.

7.2. SITEWIDE SURFACE-WATER DATA

A review of historical reports and analysis of historic data provided the basis for this investigation of surface water Pu concentrations within the SW093 drainage basin. Reports consulted include the Final Interim Measures/Interim Remedial Action (IM/IRA) Decision Document for the Rocky Flats Industrial Area (November 1994) and the IA IM/IRA Surface Water and Sediment Historical Data Investigation (July 1995). The IM/IRA reports provided a reference for characterization of radiochemical contamination in the IA. These reports were based on reviews of prior characterization studies and included analyses of information about the geochemistry of stream waters, seep/spring water, stream and seep/spring sediments, groundwater, and geologic materials.

The IA IM/IRA Surface Water and Sediment Historical Data Investigation identified the 300, 500, and 700 area buildings as possibly the primary sources of contaminated surface-water runoff received by SW093. Elevated Am activities have been detected at levels exceeding the RFCA Action Level Framework value of 0.15 pCi/l at several of the sampling locations located north of buildings 371 and 771. As noted in Progress Report #2, in-situ gamma spectroscopy data collected by EG&G show potential sources of Pu and Am contamination in surficial materials between Buildings 664 and 559 (an area within both SW093 and GS10 drainages) and north of Buildings 771 and 779 (within the SW093 drainage). These areas are potentially sources of radionuclide-contaminated runoff from the Protected Area as observed at SW093.

Historic data for this investigation were derived from the Rocky Flats Soils and Water Database (RFSWD, formerly RFEDS). Only sampling locations tributary to SW093 were included in this investigation (see Figure 7-17 for locations). Tributary sampling locations were identified using the Site's Geographic Information System (GIS) to select sampling locations within the SW093 drainage boundaries. The Site GIS system generated a sampling location list of 29 surface-water sampling locations within the SW093 drainage basin. The query was formulated to select the historic radioanalytical data RFSWD query which excluded results rejected by validation. The query produced 690 radioanalytical data records, which were sorted by location and analyte type. The sorted data were filtered to limit the results to field real samples with laboratory-reported target results. Field and laboratory QC data were not examined. The filtered data were inspected and mapped to identify portions of the SW093 drainage basin associated with higher Pu activities in surface-water runoff. These maximum Pu activities are presented here in Table 7-3 and posted in map view on Figure 7-17.

The highest surface-water Pu activity observed within the SW093 drainage basin was 0.54 pCi/L at sampling location SW086. SW086 receives surface water from Bowman's Pond, which likely receives stormwater runoff from the paved area north of Buildings 771 and 774 and footing drain discharges.

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Table 7-3. Maximum of Total Pu Activity for Each Sampling Location.

Location Code	Maximum Measured Pu Activity (pCi/L)	Sample Date
SW018	0.008	September 9, 1991
SW043	0.021	March 25, 1991
SW084	0.440	February 6, 1990
SW086	0.542	October 10, 1990
SW102	0.070	July 17, 1990
SW116	0.006	April 10, 1991
SW117	0.000	April 10, 1991
SW118	0.009	June 26, 1991

7.3. DATA GENERATED BY RECENT SITE PROJECTS

Site closure activities, including building D&D work, ER projects, excavation work and routine day-to-day operations are ongoing continually throughout the Site. Activities conducted during FY97 were assessed to determine whether or not they represented a plausible source of the Pu that resulted in the elevated activities observed at gaging station SW093.

7.3.1. D&D Work

Deactivation activities occurred throughout the Site in FY97. These Site closure activities were examined, in conjunction with water quality sampling results, to assess whether or not there was a connection between building deactivation projects and elevated Pu activity measured in the runoff to North Walnut Creek at station SW093. Deactivation work during 1997 that was located within the North Walnut Creek drainage included the following:

- **Building 779** - Deactivation activities performed in Building 779 in FY97 included lab-packing of chemicals, sampling for asbestos, removal of non-contaminated excess equipment, and removal of a contaminated filter from Room 154. No demolition work was performed during this time frame. The building provided a protective envelope for preventing releases to the environment and such activities were strictly controlled and monitored for radioactive releases by Radiation Control Technicians (RCTs). Accordingly, this deactivation work is not thought to have been the source for radionuclides that caused elevated Pu activity in surface-water samples collected at SW093[13].

- **Building 371** - Deactivation activities performed during FY97 in Building 371 included draining of tanks and piping systems containing Pu nitrate solution, partial decontamination of three rooms highly

[13] Reference: Verbal communication with K. Zbryk, RMRS, 12/12/97.

contaminated with Pu, and construction activities within the building walls for future Pu treatment systems. No demolition work was performed during this time frame. Similar to Building 779, this work was strictly controlled and monitored for radioactive releases by RCTs. Although some of the deactivation work in Building 371 involved high levels of Pu activity, the control measures and monitoring implemented in conjunction with the protective envelope of the building make this deactivation work not appear to be the cause of the elevated Pu activity observed at station SW093[14].

- **Building 771** - Deactivation activities performed in 1997 in Building 771 included draining of tanks containing Pu nitrate solution, removal of rubberized glovebox shielding material (low-level contamination), draining of liquids from idle equipment (low-level contamination), draining of cooling tower fluid (non-radioactive liquids), and removal of approximately 1,300 excess chemicals (radiologically screened). Again, these activities were conducted under conditions closely monitored by RCTs for radioactive releases and no demolition work was performed. Consequently, deactivation work in 771 is not thought to have caused the elevated Pu activity observed at station SW093[15].

7.3.2. ER Projects

No major ER projects occurred in 1997 within the basin that drains to surface water sampling station SW093 (North Walnut Creek). ER projects from the past two years that are, however, of some interest to this investigation are described below.

The Mound and T-3/T-4 Projects - Two major ER projects in 1996 and 1997 that involved significant soil disturbance, the Mound project and the Trenches T-3 and T-4 project, were both located in the South Walnut Creek drainage, not the North Walnut Creek basin monitored by SW093. Consequently, direct runoff from these projects would not be suspected of causing the elevated Pu levels observed at SW093. In addition, for reasons detailed in Section 4.4.2 of Progress Report #2, these ER projects are not suspected of contributing airborne Pu that impacted water quality at the Site.

Building 774 CERCLA Tanks - An ER project located in the SW093 drainage basin occurring from February to September, 1996, that did not involve soil disturbance was the removal of process waste from high priority process waste tanks in Building 774. Following the process waste removal, the tanks were rinsed and foamed in place. This activity was continuously monitored by RCTs for radiological releases, and the timing of the project does not correspond with the elevated measurements detected at SW093 (elevated Pu activity was measured at SW093 in August 1997). This ER work, therefore, is not suspected of contributing to the increased Pu activity measured at station SW093.

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[14] Reference: Verbal communication with K. Carnahan, SSOC, 12/12/97.

[15] Reference: Verbal communication with L. Langlios, SSOC, 12/12/97.

7.3.3. Excavation Work and Routine Site Operations

Excavation work and routine operations at the Site are subject to the Site Incidental Waters program. Water collected in utility pits, valve vaults, or excavations is sampled prior to being dispositioned. Following sampling, such water is pumped to the ground if the water quality is acceptable, or sent to an onsite treatment facility if sample results indicate the water is not suitable for a release to the environment.

Soil disturbance in the SW093 basin occurred in March 1997 when a new double-walled diesel tank was installed east of Building 779. However, limited samples collected from monitoring station GS32, located immediately downstream from this excavation work (and a source of runoff to station SW093) did not show any elevated Pu activities during this time frame (data are presented in Section 0). This soil disturbance is therefore not suspected of causing elevated Pu activity at station SW093.

7.3.4. Summary of Recent Site Activities Impact on SW093

For the reasons outlined above, there is no indication that recent D&D, ER, excavation, nor routine operations work resulted in a release that caused the elevated Pu activities measured at station SW093 in August, 1997. The elevated activity at SW093 is thought to have been caused by Pu source(s) created by atmospheric fallout, historic Site operations, and natural actinide transport processes.

7.4. GAMMA SPECTROSCOPY INFORMATION

In FY93 and FY94, IA Operable Units were surveyed by gamma spectroscopy instrumentation using a High Purity Germanium (HPGe) detector. The HPGe instrumentation was used to measure Am-241 activities in IA surficial soil materials. Am-241 is a decay product of Pu, hence it is an important indicator of potential Pu sources. These gamma spectroscopy data are of somewhat limited utility because of the large radius of investigation (approximately 30 feet) used for the measurements. This radius of investigation created the potential for monitoring results to be errantly impacted by activity emitted from within nearby buildings, often referred to as "shine," and also to miss small, localized activity sources. With these factors in mind, the results from this survey were reviewed as part of the SW093 source investigation.

Data mapping (Figure 7-18) indicates that, within the SW093 drainage basin, elevated surficial transuranic activity may exist in the soils near Building 713 (east side) and Building 964 (all sides).

7.5. SOIL AND SEDIMENT INFORMATION

A review of historical reports and analysis of historic data provided the basis for this review of soil and sediment Pu activities within the SW093 drainage basin. As for the surface-water review, this soil and sediment review relied on information in the Final IM/IRA Decision Document for the Rocky Flats IA (November 1994) and the IA IM/IRA Surface Water and Sediment Historical Data Investigation (July 1995).

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As discussed in Progress Report #2, the IM/IRA soil monitoring program sought to characterize temporal changes in Pu activities, as spatial and vertical distribution of Pu according to specific remediation areas. Annual sampling of a circular array of sampling stations was performed to investigate Pu distribution patterns using the IA as a point source. Samples were collected from 40 sampling locations and evaluated for changes in Am and Pu activities as a result of soil resuspension or other mechanisms. The minor temporal variations observed were attributed to heterogeneity of the wind-deposited actinides in soil. Pu and Am activities at annual sampling locations outside the IA exhibited much less variation and were typically at or near background activities.

Historic radioanalytical data for this soil/sediment assessment were also retrieved from RFSWD. Only sampling locations tributary to SW093 were included in this investigation (see Figure 7-19 for locations). A total of 198 tributary surface soil and sediment sampling locations identified by the Site's GIS were used to formulate an RFSWD query for historic radioanalytical data (excluding results rejected by validation). The query produced 2,579 radioanalytical data records, which were sorted by location and analyte type. The data were then filtered to limit the analysis to only represent field real samples with laboratory reported target results. The maximum Pu activity values for each location were selected from the filtered data set which resulted in 258 values for statistical analysis. To evaluate the data, a frequency distribution plot was generated using the logarithmic sized bins (i.e., -0.01, 0.0, 0.01, 0.1, 1.0, 10.0, 100.0, and 1000.0) for grouping maximum Pu values. The results of the analysis are plotted in Figure 7-20. Additionally, Figure 7-19 uses color coded symbols to represent the maximum Pu activities measured at each sampling location. The colors were selected to grade from low Pu concentrations to high Pu activity (i.e., black through green, to yellow, to orange and ending red) to identify areas of higher Pu contamination.

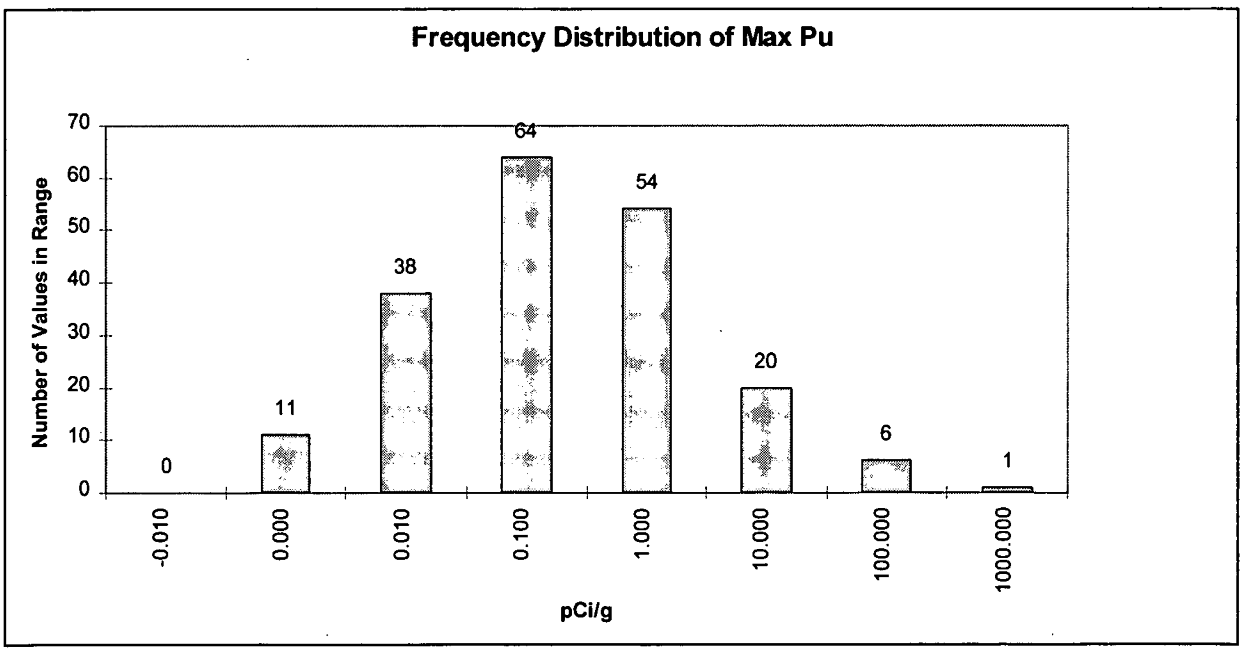

Figure 7-20. Frequency Distribution of Maximum Pu Activity for Sampling Locations Within the SW093 Drainage Basin.

A review of the soil and sediment maximum values indicate orders of magnitude differences in Pu activities for contaminated soils and sediments within the IA. Most of the maximum Pu values, 64 results, were observed in the 0.01 to 0.1 pCi/g range. The second greatest count, 54 results, were observed in the 0.1 to 1.0 pCi/g range. The overall distribution was log normal, as is expected of actinide contamination data. Only 1 measurement fell in the extreme high value range of 100 to 1,000 pCi/g. This highest Pu value, 115.3 pCi/g, was measured at sampling location PCB29, along the northeast perimeter of Building 779.

7.6. HISTORICAL RELEASE REPORT[16] INFORMATION

A multitude of potential sources of radionuclide contamination exist within the drainage basin leading to SW093. From the Site Historical Release Report (HRR), multiple Pu and general radionuclide-contaminated IHSSs were identified to be completely or partially within this drainage. The Pu IHSSs are listed and described in Table 7-4.

General radionuclide (rad) IHSSs in the SW093 drainage include PAC #'s 128,150.1, 150.6, 150.8, 156.1, 158, 159, 170, and 181. These IHSSs resulted from a variety of incidents and activities including spills from process waste lines and waste boxes, burning of contaminated oil, and leaking storage drums and barrels. Details of some of these releases are compiled in the following paragraphs. This information is not intended to be complete, due to the number of IHSSs, but rather it is intended to be representative of the types of events that have occurred which may have led to potential contamination sources within the basin. In addition to recorded IHSSs, the SW093 drainage contains multiple exposed-dirt parking surfaces and roads common in the IA.

The HRR mentions numerous incidents of leaks or ruptures in the process waste lines. One such rupture from B559 caused soil contamination with an activity of 4,500 pCi/g (1972). In May, 1977, 4,600 gallons of contaminated water leaked into a process waste collection tank in B528. Gross alpha in the water was measured at 160,000 pCi/L. Leakage of waste boxes being loaded into railroad container cars is suspected of causing residual contamination in the area north of B551, from September 1959 through 1970. Shipments measuring 6,000 to 40,000 cpm were held back at this location (September 1959). Additional sources of contamination include overflows of laundry wastewater tanks from B730 (1956-October 1984).

Exposed storage of equipment and drums, and various other leaks and spills have led to contamination within the SW093 drainage. Multiple incidents of leaking drums and barrels contaminated asphalt and gravel surfaces north of B771 with levels ranging from 500 to 1,000,000 cpm (1957-1974). Radioactive contamination occurred south and northeast of B779 because of improperly opened waste drums in the building that were spread by pedestrian tracking (June 1969). The radioactive waste was measured up to 50,000 dpm/100 cm^2 for gross alpha activity. The PU&D storage yard, used for storing empty drums,

[16] U.S. Department of Energy, 1992, *Historical Release Report for the Rocky Flats Plant*, Rocky Flats Environmental Technology Site, Golden, CO, June.

dumpsters, cargo boxes, cable spools, and similar materials from 1974-present, is suspected of harboring potential contamination. A spill of a small amount of unknown radioactive powder was reported in the main storage area in December 1987. A cargo container to the north of B334 was used for storage of machine oils, solvents, machine coolants, and possibly low-level radioactive wastes, however no documentation of spills or leaks was found in relationship to this unit.

Table 7-4. Selected IHSSs in the SW093 Drainage.

IHSS #	LOCATION/BLDG.	DATES	DESCRIPTION
124.1 124.2 124.3	700 Area Tanks #66,67,68	1953-1989	An overflow from Tank #66 in July, 1981 spilled an estimated 500 gallons of liquid waste. The wastewater was contaminated with approx. 40,000 dpm/L of Pu. The area was paved following the incident, but the contamination may not have been removed prior to paving.
126.1, 126.2	700 Area Out of Service Process Waste Tanks	1953-1984	Concrete tanks below B728 overflowed several times prior to 1956, and were suspected of leaking during use. Liquid process wastes in the tanks contained Pu and U.
127	700 Area B774	October 1957-1971	Periodic leaks in the process waste lines contaminated soils with small amounts of Pu. A 1976 soil sample from a depth of 4 feet beside the leak area contained 1.83 dpm/g Pu.
131	700 Area Radioactive Site #1	June 1964 and May 1969	An explosion in B776 contaminated an area of soil with Pu greater than 200,000 dpm/67 cm^2 in June 1964. In May 1969, the same area was radioactively contaminated from firefighting activities.
143	700 Area 771 Outfall	1953-1971	Sources of Pu-contaminated wastewaters discharged from B771 to a storm drain northwest of the building included laundry holding tanks, analytical laboratory and radiography sinks, the personal decontamination room, and runoff. Discovery of a hot spot in April 1970 showed soil samples greater than 190,000 dpm/g Pu.
144	700 Area Sewer Line Overflow	June 7, 1972	Radioactive laundry wastewater was released between buildings 779 and 777 from a sewer line break. Samples were found to contain 136,000 pCi/L of total alpha-emitting radionuclides.
146.1- 146.6	700 Area Concrete process waste tanks	Prior to 1956-1972	Overflows from underground process waste holding tanks containing Pu and other constituents, resulted in contamination levels of 2,500 dpm/g gross alpha activity.

IHSS #	LOCATION/BLDG.	DATES	DESCRIPTION
149.1 149.2	700 Area Effluent Pipe	1972-1980	Process waste line leaks near B774 released approximately 1000 gallons of radioactive wastes to the environment. Analysis showed 2,500 pCi/L total alpha activity.
150.2	700 Area Radioactive Site W of B771 & B776	Sept. 11, 1957 and May 11, 1969	Fires in buildings 771 and 776/777 resulted in Pu contamination on the west and southwest sides of the buildings. Contamination measured as high as 6,000 cpm.
150.3	700 Area Radioactive Site Between B771 and B774	Aug., Sept., Dec. 1971	Breaks in the process waste lines resulted in the release of Pu to the soil (Aug.), and soil contamination of 24 dpm/g (Sept.). The December incident released wastewater at a concentration of 1000 pCi/L.
172	Central Avenue Waste Spill	June 11, 1968	A drum being transported from the 903 Drum Storage Area to B774 leaked, causing contamination to the roadways traveled. Radioactive materials spilled including Pu-contaminated oils and radioactive waste oil.
186	300 Area Valve Vaults 11,12,13	1985-1989	Several incidents have occurred in one or more of these valve vaults resulting in the release of process waste to the environment. Alpha contamination measured up to 1.7×10^5 pCi/L. Water samples indicated the presence of Pu and other constituents.

A contaminated soil pile north of B334 raised some contamination concerns because it was located in the construction area for B371. Inspection of aerial photographs shows evidence of soil being placed in this area as early as 1969 from unknown activities. Soil samples had 3-704 dpm/g. In August 1956, an experiment was conducted that involved the burning of contaminated oil in a pit located north of B331. Approximately 6-10 drums were burned that originated from buildings 444 and 881 and were contaminated with depleted uranium (U-238). A direct survey of the soils and oil residue within the pit showed meter readings of 500 and 750 cpm alpha activity. After the burning operation, the residue was left in place and the pit backfilled.

Several activities took place concurrently with historic releases which may have affected the migration of contaminants from their source of origin. Both facility expansion involving movement of potentially contaminated sediments and construction and maintenance of dirt parking surfaces and roads, make it reasonable to expect that vehicular traffic mobilized potentially contaminated surficial soils. Site expansion was accompanied by increased waste-producing activities. Storage and disposal practices were changed in order to accommodate the increased waste, but instead created several of the areas of concern addressed above. Additionally, storm events, characterized by heavy rains and high winds, were frequent mechanisms for dispersion of contaminants.

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It is evident that Site sediments in the SW093 drainage basin have a lengthy history of contamination from historical releases. Documentation is limited however, regarding the fate and mobility of contaminants in the environment from a particular IHSS. Many of the IHSSs described above contain similar constituents, are in close proximity to each other, and oftentimes overlap. An attempt to isolate a particular IHSS as a sole contributor to elevated radionuclide levels at SW093 will be time-consuming and possibly inconclusive. Multiple IHSSs could collectively be considered a single source of contamination. While several factors affect the ability to identify and fully characterize the above IHSSs, historical information currently supports the existence of widespread contamination throughout the SW093 basin.

7.7. GROUNDWATER DATA

All groundwater data discussed in this document were retrieved from RFSWD for wells within the SW093 drainage. The RFEDS query yielded data from November 1989 through January 1997. All radionuclide activity results discussed are unfiltered, total radionuclides. Sample results rejected in the data validation process were not considered. Duplicate samples and laboratory replicates were averaged with real samples as appropriate.

7.7.1. Groundwater Monitoring Near SW093

The uppermost, unconfined aquifer within the SW093 drainage flows from west to east across the Site through the Rocky Flats Alluvium and Arapahoe and Laramie Formations. There is no known direct hydraulic connection between this shallow alluvial aquifer and deeper confined aquifers extending off-Site (Kaiser-Hill, 1994). In the spring and early summer, this shallow alluvial aquifer of the Rocky Flats Alluvium and Arapahoe Formations is recharged by precipitation and lateral groundwater flow. In the late summer and early fall, these formations are recharged primarily by groundwater lateral flow. In the Walnut Creek stream drainages, groundwater discharges as seeps which typically occur at the base of the Rocky Flats Alluvium where individual sandstone lenses become exposed to the surface (Kaiser-Hill, 1994).

In accordance with the Integrated Monitoring Plan (DOE, 1996), the uppermost unconfined aquifer is currently monitored for Pu-239,240 and Am-241 in four monitoring wells within the boundaries of the SW093 surface water drainage: B208789, P209289, P209389, and P29189 (Figure 7-23). Sampling of these wells is performed quarterly to semi-annually. RFSWD contains records of Pu-239,240 and Am-241 sampling in 31 wells across the SW093 drainage, dating back to 1989. Historical sampling frequencies for many of these wells are not clear, varying between weekly and semi-annual. All groundwater samples discussed in this document were collected using bailers.

7.7.2. Summary of Groundwater Data

Historically Sampled Wells

Of the 31 groundwater wells within the SW093 drainage historically sampled for Pu-239,240, RFSWD shows only one to have yielded results for unfiltered Pu-239,240 exceeding 0.15 pCi/L. This well, 2286, is located just southwest of the solar evaporation ponds as shown in Figure 7-23. In addition to being close to the solar evaporation ponds, 2286 is adjacent to the Pu-239,240-contaminated IHSS #149.2. IHSS #149.2 marks the location of underground process waste line leaks which occurred during the 1970s. Total radionuclide activities and total suspended solids concentrations in samples collected from well 2286 are presented in Figure 7-22 and Figure 7-24, respectively.

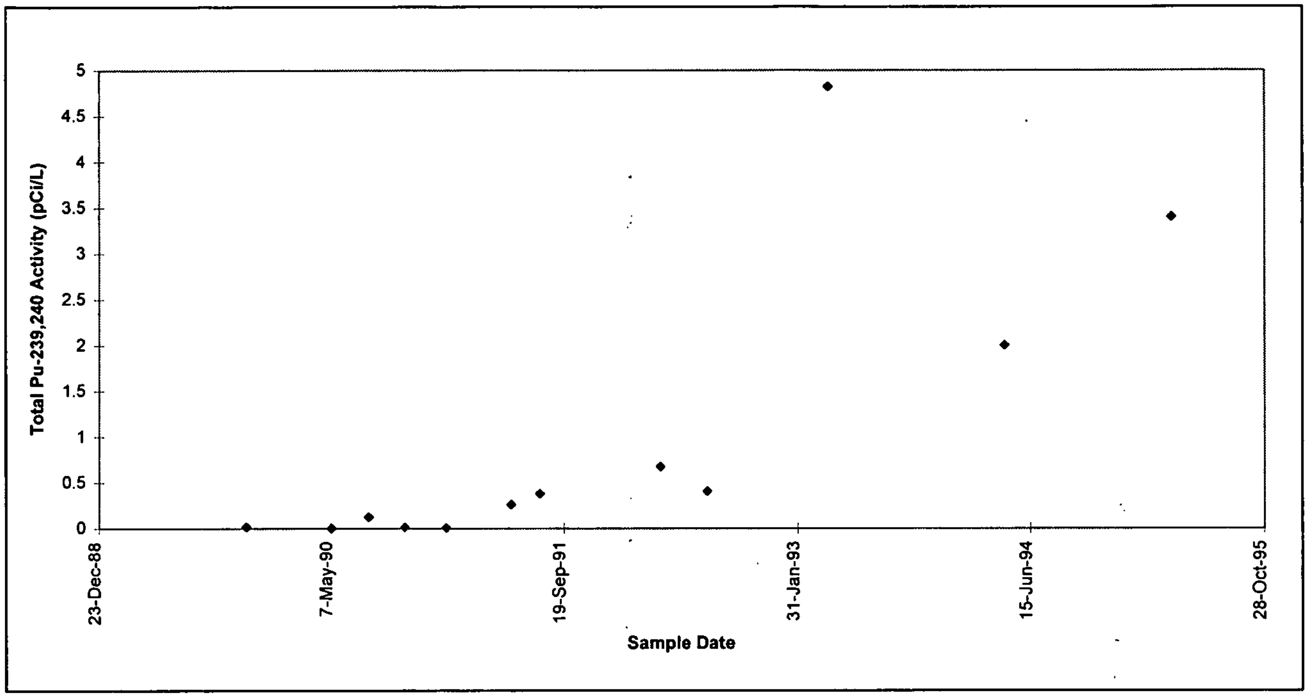

Figure 7-22. Total Pu-239,240 in Groundwater Samples from Well 2286.

Figure 7-22 indicates a possible increasing trend in total Pu-239,240 in well 2286; however, the numerical correlation with time is poor. Further, the most recent sample is from July 1995. The total suspended solids data in Figure 7-24 suggest no significant trend with time.

Currently Sampled Wells

Of the four wells within the SW093 drainage currently sampled for Pu-239,240, RFSWD contains analytical results from only one, P209389. Total radionuclide activities and TSS concentrations in samples collected from well P209389 are presented in Figure 7-25 and Figure 7-26, respectively.

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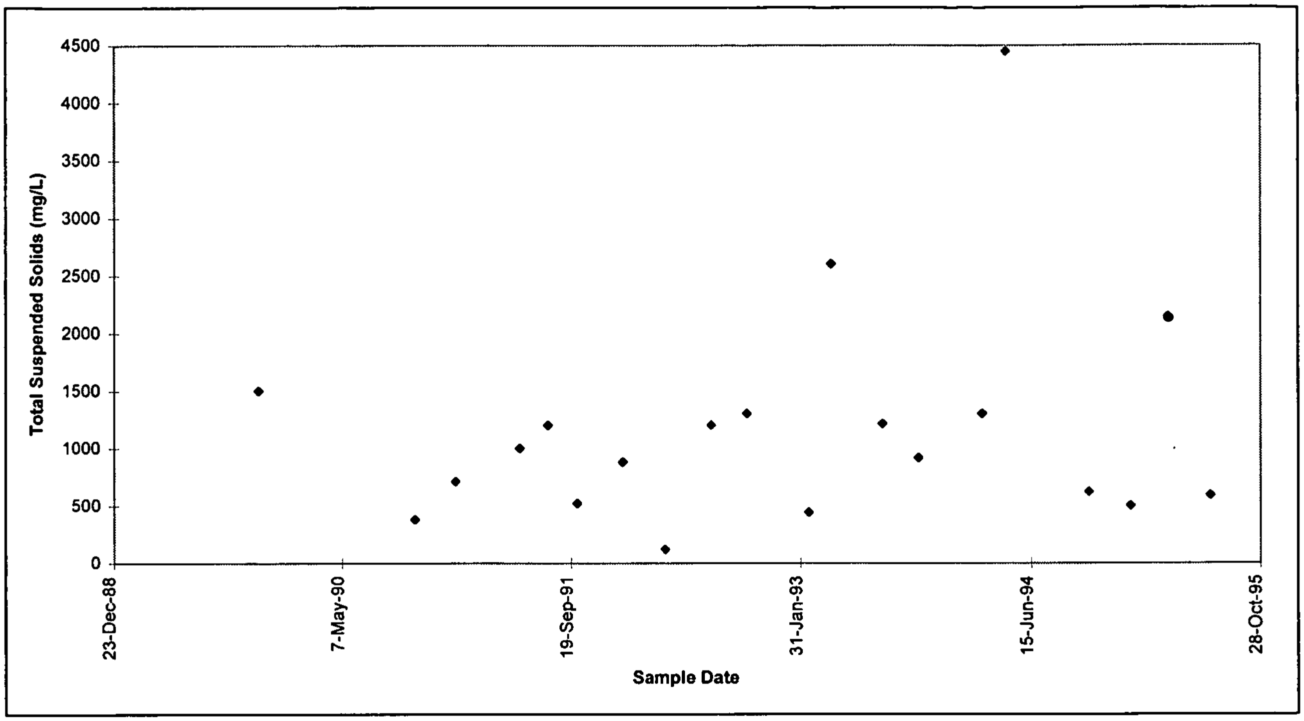

Figure 7-24. Total Suspended Solids in Groundwater Samples from Well 2286.

As shown in Figure 7-25, total Pu-239,240 results from well P208389 are all low and relatively constant. Likewise, Figure 7-26 shows that total suspended solids data exhibit no significant trend with time. It is important to note that the most recent Pu-239,240 data available is from January 1997.

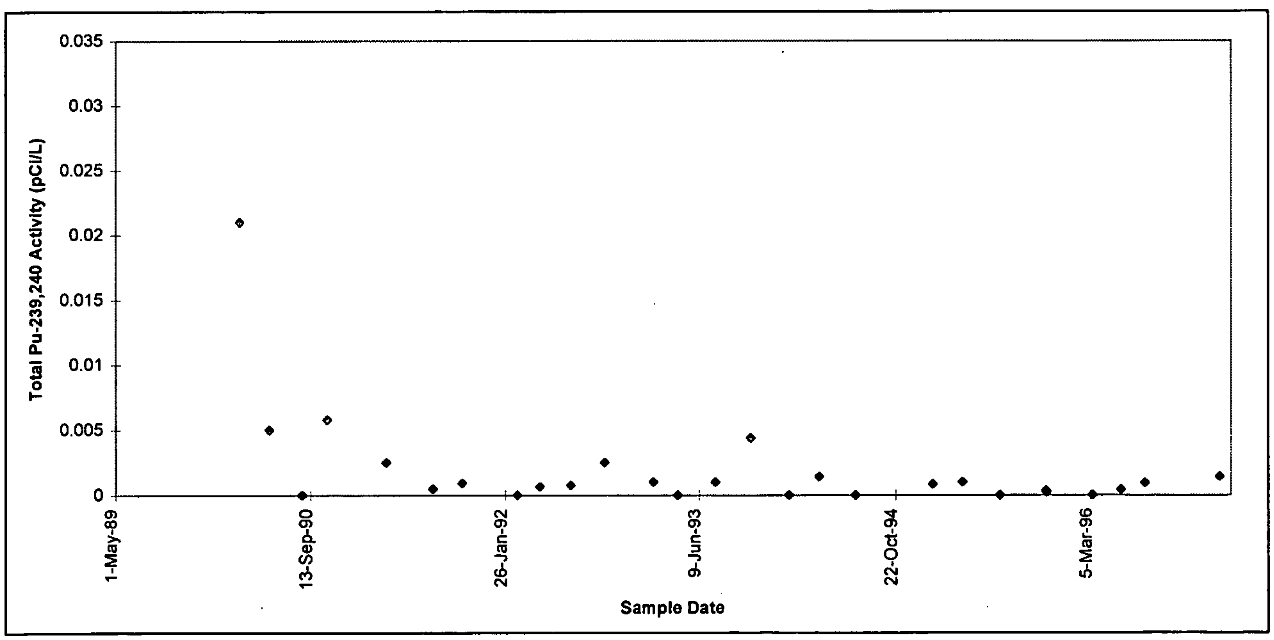

Figure 7-25. Total Pu-239,240 in Groundwater Samples from Well P208389.

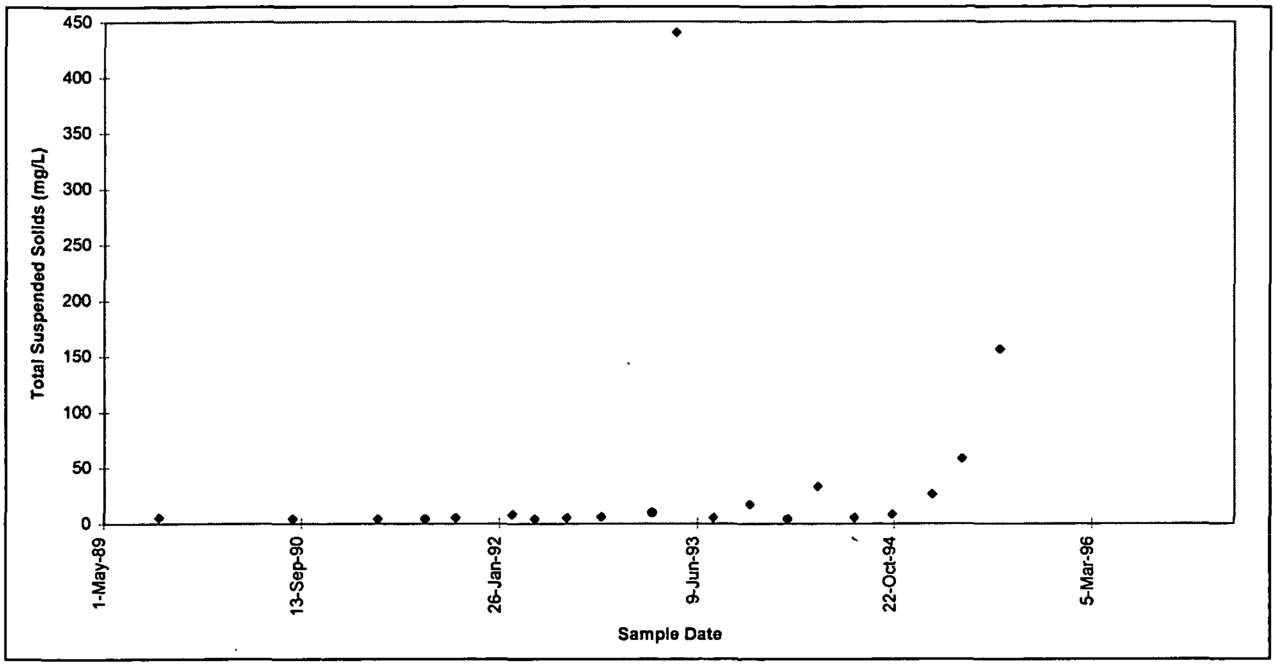

Figure 7-26. TSS in Groundwater Samples from Well P208389.

Groundwater Elevation Data

Groundwater table elevation is measured monthly to quarterly at all actively sampled wells. Groundwater wells B208789 and 1786 are upgradient and downgradient of SW093, respectively, as shown in Figure 7-23. Record of water table elevations retrieved from RFSWD for these two wells are presented in Figure 7-27 and Figure 7-28.

The mean groundwater table elevation at well B208789 is 5899.95 feet above sea level, while the mean groundwater table elevation at well 1786 is 5863.15 feet. This represents an average drop of nearly 37 feet across the 825 horizontal feet separating these two wells. Considering this and the geology of the area, it is likely that groundwater seeps on the hillside above SW093, where individual sandstone lenses are exposed, contribute measurably to the surface water flow observed at SW093. The elevation of surface water gauging station SW093, between these two wells is roughly 5,866 feet above sea level.

7.7.3. Analysis of Groundwater Data

Historical Data

Historical data from wells currently and formerly sampled for Pu-239,240 do not indicate significant radionuclide contamination of groundwater within the SW093 drainage. The only well with record of total Pu-239,240 activity exceeding 0.15 pCi/L, well 2286, is adjacent to an underground, Pu-contaminated IHSS. The lack of elevated Pu data in the record from any of the other 31 wells sampled within the drainage suggests that the contamination may be confined to a relatively limited area or may be the result of well construction or sampling methods as discussed in Source Evaluation Progress Reports #1 and #2.

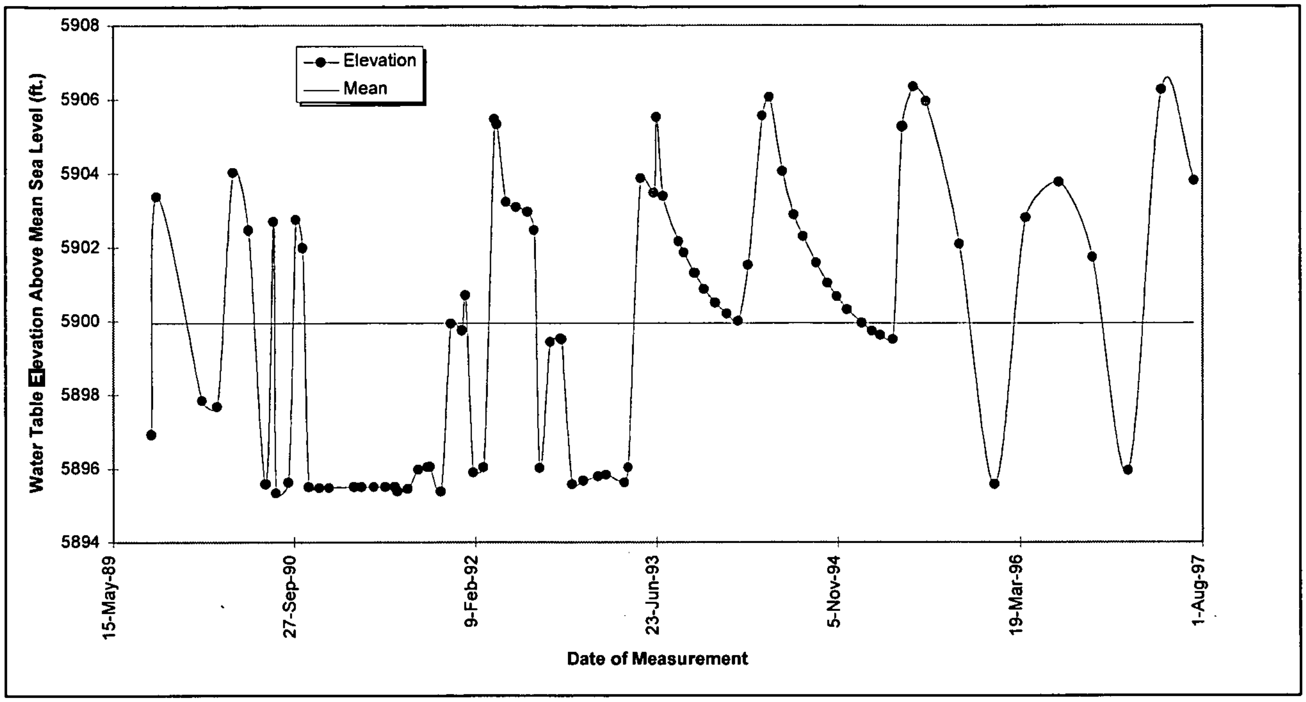

Figure 7-27. Groundwater Table Elevations at Well B208789.

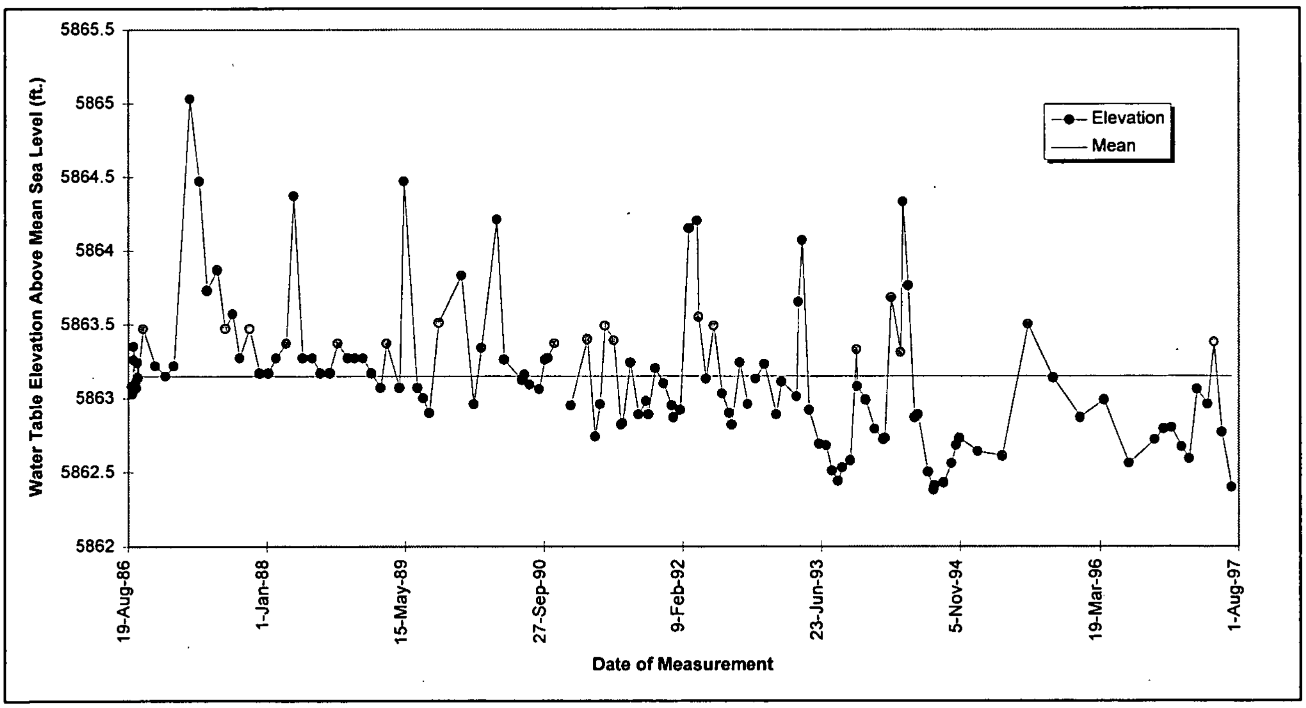

Figure 7-28. Groundwater Table Elevations at Well 1786.

Baseflow Analysis

Both the geology of the area and the groundwater elevation data suggest that groundwater seeps contribute directly to surface water flow gaged at SW093. Consequently, baseflow at SW093 is comprised of groundwater seeps, footing drain discharges (as evidenced by flow at GS32), and possibly domestic line leaks. Baseflow was estimated from the SW093 hydrograph for WY97 to facilitate comparison of baseflow contribution and surface-water activity. The results of this analysis are presented in Figure 7-29. No significant correlation is observed between baseflow contribution to SW093 and sample activity. This implies that groundwater is not likely to be a primary source of contamination of surface water at SW093.

This is further supported by consideration of two particular data points. First, as seen in Figure 7-29, when the sample Pu activity reached 1.3 pCi/L (August 1, 1997), the estimated percent baseflow contribution was only around 1% of the total flow at SW093. Assuming that the baseflow is comprised exclusively of groundwater, this activity would require a groundwater Pu activity of 130 pCi/L. Second, the sample started only one month later (September 1, 1997) exhibited a Pu activity of only 0.002 pCi/L, though baseflow was contributing over 60% of the total flow. Again, if the baseflow is assumed to be comprised exclusively of groundwater, and groundwater assumed to be the primary source of the contamination, groundwater activity would have to have been roughly 0.003 pCi/L. This information is summarized in Table 7-5.

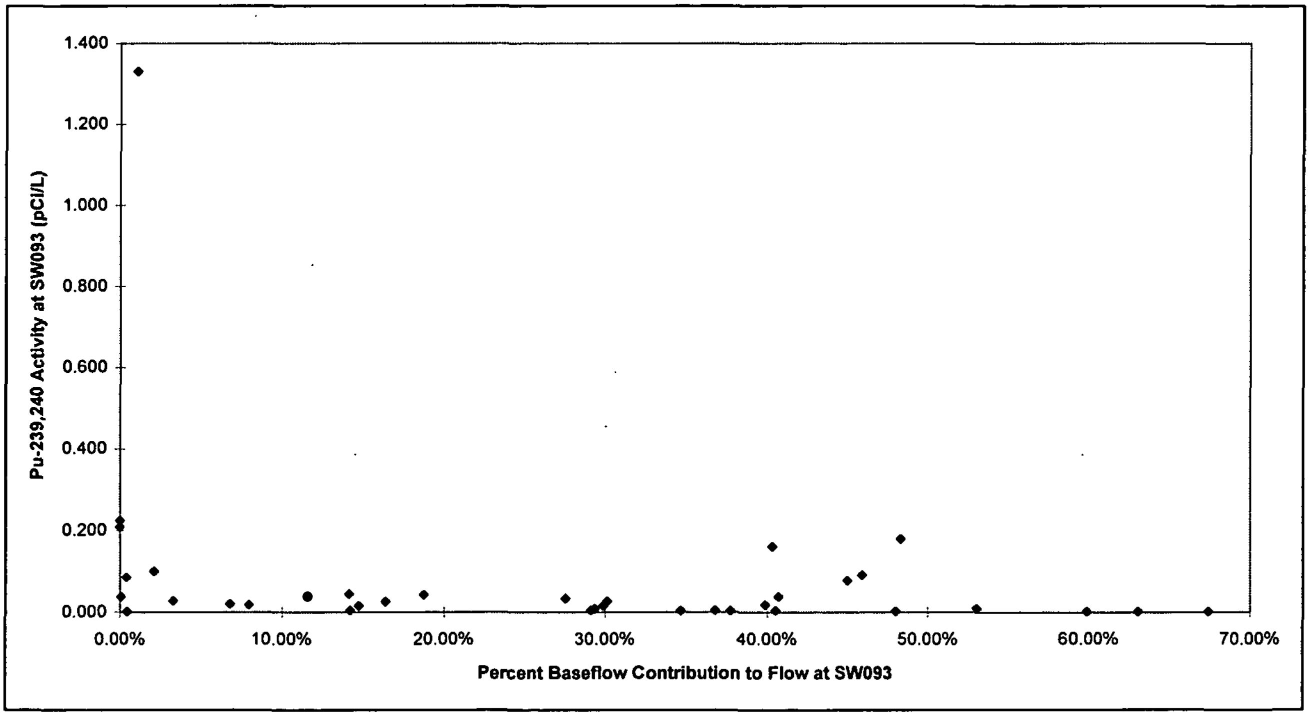

Figure 7-29. Relationship Between Estimated Baseflow Contribution and Flow-Paced Sample Activity at SW093.

Table 7-5. Analysis of Percent Baseflow Contribution and Surface Water Pu-239,240 Activity

Sample Start Date	Sample Pu-239,240 Activity (pCi/L)	% Baseflow at SW093	Correspondingly Required Groundwater Activity (pCi/L)
8/1/97	1.300	1%	130.000
9/1/97	0.002	63%	0.003

Expectation of a concentration decrease of more than 100 pCi/L-Pu over the time frame of one month is not reasonable for groundwater. Consequently, it seems unlikely that groundwater is a primary source of the radionuclide contamination observed at SW093.

8. SW093 SOURCE LOCATION ANALYSIS: HYPOTHESES AND CONCLUSIONS

In the following section, a discussion of source hypotheses for SW093 is presented. To date, a singular source for SW093 can not be identified. Information collected to date does not point to any singular conclusion. In fact, it is likely that multiple sources and transport mechanisms are responsible for the elevated activities at SW093.

8.1. WIDESPREAD OR LOCALIZED SOIL AND SEDIMENT CONTAMINATION IN SW093 DRAINAGE

Site sediments have a long history of contamination from historical releases. The section on historical releases (see Section 7.6) identifies numerous events from the Site's production era which introduced radioisotopes to Site drainages via both airborne and surface-water runoff deposition. In Section 7, historic reports and a review of existing soil/sediment data indicate widespread Pu contamination of soils and sediments throughout the SW093 drainage. Airborne contamination would result in more distributed contamination, with levels diminishing further from localized sources. The movement of contaminated soils and sediments in runoff could result in localized contaminated deposits or more evenly distributed contamination, depending on how active natural erosion processes are in the SW093 drainage. The SW093 drainage includes numerous Pu source areas.

Soil and sediment activities for samples in the drainage show a range of zero to more than 100 pCi/g (see Section 7.5). The highest values are associated with soils near B779. The maximum TSS measured to date at SW093 is 1,900 mg/L. At these levels of TSS and assuming uniform suspension of soils, a soil with 0.1 pCi/g could yield activities of 0.19 pCi/L. Given the soil activities in the drainage, the recent elevated activities at SW093 are possible.

Section 7.5 indicates that the SW093 sub-basins may all contribute Pu load to SW093 at varying levels, further supporting the hypothesis of multiple or widespread source areas. It is also possible that soils are eroded, moved by overland flow, and re-deposited in ditches with each passing storm runoff event. These deposited sediments could then be re-suspended by subsequent events to provide Pu activity at SW093.

Data collected from the Source Location monitoring locations (see Section 10.2.3) will further determine the proportions of Pu load that each monitored sub-basin may be contributing. If a certain sub-basin is determined to be contributing a significant proportion of the load at SW093, watershed improvements can be used to mitigate further transport. These types of watershed improvements have been demonstrated for other locations around the Site, specifically at GS27 (see Section 9).

8.2. GROUNDWATER SOURCE

One hypothesis to explain the elevated levels of Pu and Am observed at SW093 is groundwater contamination of surface water. This hypothesis is supported by the existence of groundwater seeps at the base of the Rocky Flats Alluvium and the presence of numerous Pu-contaminated IHSSs within the drainage. The available sampling and flow monitoring evidence, however, does not support this hypothesis.

As discussed in Section 7.7, wells within the SW093 drainage currently sampled for radionuclides exhibit no elevated activities or trends with time. Examination of the historical records revealed only one well, of 31 wells historically sampled, with Pu results exceeding 0.15 pCi/L. All evidence suggests that this contamination, located near a Pu-IHSS and the solar evaporation ponds, is not widespread. Further, these data are questionable due to limitations of well installation and sampling techniques as suggested by extremely high TSS values.

The lack of a significant relationship between baseflow contribution and surface-water activity at SW093 further disputes the hypothesis that groundwater is a primary source of radionuclide contamination at SW093. Two surface water composite samples started within one month of each other exhibit drastically different relationships between baseflow contribution and surface water Pu activity. One sample, started on August 1, 1997, was collected during a time of low baseflow (roughly 1% of total flows) and had a Pu activity of 1.3 pCi/L. A second sample, started September 1, 1997, was collected during a time of high baseflow contribution (more than 60% of total flows) and had a Pu activity of only 0.002 pCi/L. Given this data, for groundwater to be a primary source of the contamination observed at SW093, groundwater Pu activity would have had to drop from 130 pCi/L in August to 0.003 pCi/L in September. Such a drastic change over such a short period of time is extremely uncharacteristic of groundwater. Further, the highest total Pu activity observed in any groundwater sample within the SW093 drainage was more than an order of magnitude less than 130 pCi/L at 4.8 pCi/L.

The available evidence does not support the hypothesis that groundwater seeps are a major source of radionuclide contamination of surface water at SW093. Results of groundwater samples recently collected within the SW093 drainage will be reported as soon as they become available.

8.3. TRIBUTARY SURFACE-WATER SOURCE

Another hypothesis to address is that radionuclide contamination of surface water observed at SW093 originated from surface water tributary to SW093. Section 7.5 indicates that the SW093 sub-basins may all contribute Pu load to SW093 at varying levels, supporting the hypothesis that tributary surface water is carrying load toward SW093. Data collected from the Source Location monitoring locations (see Section 10.2.3) will further determine the proportions of surface-water Pu load that each monitored sub-basin may be contributing. If a certain sub-basin is determined to be contributing a significant proportion of the load at SW093, watershed improvements can be used to mitigate further transport in surface water. These types of watershed improvements have been demonstrated for other locations around the Site, specifically at GS27 (see Section 9).

9. EVALUATION OF WATERSHED IMPROVEMENTS ON PU TRANSPORT IN THE WALNUT CREEK BASIN

9.1. BACKGROUND OF WATERSHED IMPROVEMENTS IMPLEMENTED AT THE SITE

Erosion control measures were implemented at the Site during FY96 and FY97 in an effort to stabilize and entrap soils and sediments likely to be transported from a watershed by stormwater runoff. Implementation of these measures was based on studies that indicate radionuclides may associate with solids suspended in stormwater. [17,18,19,20,21,22] Stormwater data collected at the Site between 1991 and 1996 supports this

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[17] U.S. Department of Energy, 1996, *Pond Operations Plan*, Rocky Flats Environmental Technology Site, Golden, CO, September.

[18] Little, C.A. and F.W. Whicker, 1978, "Plutonium Distribution in Rocky Flats Soil," *Health Physics*, 34, May 1978, pp. 451-457.

[19] Hanson, W.C., 1980, *Transuranic Elements in the Environment*: Technical Information Center, U.S. Department of Energy, pp. 145-162.

[20] Hakonson, T.E., R.L. Watters, and W.C. Hanson, 1981, "The Transport of Plutonium in Terrestrial Ecosystems," *Health Physics*, 40, January 1981, pp. 63-69.

[21] Webb, S.B., S.A. Ibrahim, and Whicker F.W., 1983, "A Study of Plutonium in Soil and Vegetation at the Rocky Flats Plant," *Twenty-Sixth Midyear Topical Meeting of the Health Physics Society, Coeur d'Alene, Idaho, January 24-28.*

[22] Honeyman, B.D., and P.H. Santschi, 1997, *Final Report-Actinide Migration Studies at the Rocky Flats Environmental Technology Site*, December.

conclusion (DOE, 1996)[17]. Based on these characteristics of radionuclides and stormwater, removing particulate material from stormwater runoff should reduce radionuclide loading to the water. Drainage areas targeted for control measures were those locations identified as most likely to contribute material that could provide a transport mechanism for radionuclides in Site runoff.

Although watershed improvements were implemented throughout the Site, only those improvements implemented within the Walnut Creek drainage basin will be discussed in this report.

9.2. SELECTION OF WATERSHED IMPROVEMENT LOCATIONS

Several sources of information, in conjunction with walkdowns of the Site, were used to determine locations where watershed improvements should be implemented. These information resources are listed below:

- Surface-water monitoring data;
- Gamma spectroscopy data;
- Industrial Area sediment quality data;
- Industrial Area soils data; and
- Historical Release Report information.

Items of concern noted during site walkdowns included the following items:

- Areas of concentrated fine sediments in drainage pathways;
- Areas of exposed dirt susceptible to erosion (e.g., steep dirt roads, barren hillsides, etc.);
- Erosion on radionuclide-contaminated IHSSs; and
- Position of radionuclide-contaminated IHSSs in relation to stormwater drainage pathways.

Results of the various investigative surveys were used in conjunction with findings from Site walkdowns to identify areas to target for watershed improvements. Specific types of improvement measures implemented within the Walnut Creek drainage basin are discussed in the following section.

9.3. TYPES OF WATERSHED IMPROVEMENTS IMPLEMENTED IN THE WALNUT CREEK DRAINAGE BASIN

Two types of watershed improvement measures were implemented in the Walnut Creek drainage basin during FY96 and FY97. Brief descriptions of these two hydraulically-applied erosion control products are provided below:

- TopSeal® was applied at areas of the Site targeted for erosion control where revegetation was not practical, such as dirt roads. This acrylic copolymer emulsion product is mixed with water and sprayed on using a water truck. It dries within several hours to seal and bind the soil together and does not pose a threat to water quality.

- SoilGuard® was hydraulically-applied at Site locations targeted for erosion control where revegetation was beneficial, such as exposed dirt hillsides. This material, a combination of wood fibers mixed with a guar gum tackifier and fertilizers, acts as a soil stabilizer and revegetation product and is applied by a certified contractor using a hydroseeding truck. The product can be used strictly as a soil stabilizer, without seed, or sprayed as a fixative on top of planted seeds. It dries within several hours to form a bonded fiber matrix, can withstand heavy rainfall while protecting the top layer of soil, and does not degrade water quality. New vegetative growth can protrude through the matrix without disrupting the surrounding sealed area.

9.4. IMPACTS OF WATERSHED IMPROVEMENTS ON PLUTONIUM TRANSPORT IN THE WALNUT CREEK BASIN

This section provides analyses of the impacts of watershed improvements on the transport of plutonium-239,240 in surface water at specific monitoring locations throughout the Walnut Creek drainage basin.

9.4.1. Gaging Station GS27

Station Location: 20 feet west of Building 884.

Basin Size: Approximately 0.2 acre

Basin Description: GS27 monitors flow from the dirt lot south of Building 884, including part of the former site of Building 889 (prior to D&D). Flow from GS27 goes into the Central Avenue Ditch, and continues to SW022 and on to GS10 (South Walnut Creek).

Watershed Improvements Implemented:
Sediments removed S. of B884 (7 drums; completed August 15, 1996)
TopSeal® applied S. of B884 (0.12 acre; completed October 1, 1996)

GS27 Data Plots:

Four plots are provided of various water-quality parameter relationships at station GS27, with distinctions made between the data collected before and after changes were made in the GS27 watershed. These plots are shown in Figure 9-1 through Figure 9-4. Linear trendlines were imposed on the data and, although statistical correlations for the trends are not always strong, the trends help to understand various relationships in terms of the impact of watershed changes.

Pu-239,240 activity versus time (Figure 9-1) - Pu activity in samples collected before watershed changes were implemented varied from roughly 0.9 to 90.0 pCi/L. After the watershed changes in the summer and fall of 1996, the Pu activity has varied from approximately 0.1 to 6.2 pCi/L. Data from this plot does not reflect variations in the flow rate at the time the samples were collected, but does, nevertheless, imply that the arithmetic average Pu activity has declined in runoff from the GS27 basin since the implementation of watershed changes.

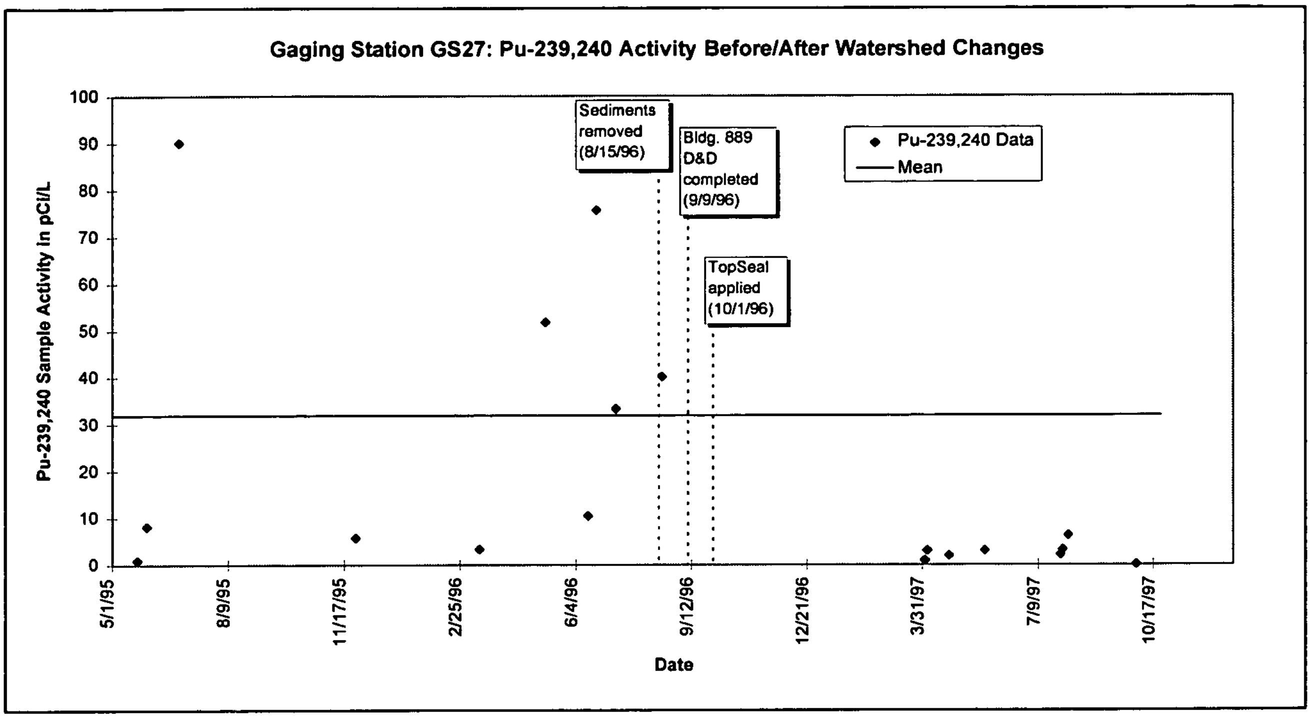

Figure 9-1. Gaging Station GS27: Pu-239,240 Activity Before/After Watershed Changes.

Pu-239,240 activity versus flow (Figure 9-2) - As referenced in Section 9.1, surface water transport of Pu is associated with particulate matter, then an increase in Pu activity is anticipated with a rise in flow rate if the physical flushing mechanism of particulate matter increases. Trendlines of this plot indicate that, following the watershed changes, the amount of Pu flushed from the GS27 basin for a given flow rate was reduced by roughly sevenfold. Plotting of relationships between other variables in the GS27 basin was performed (Figure 9-3 and Figure 9-4), and are discussed below, to help identify the watershed change mechanism(s) responsible for this favorable reduction in the Pu to flow ratio.

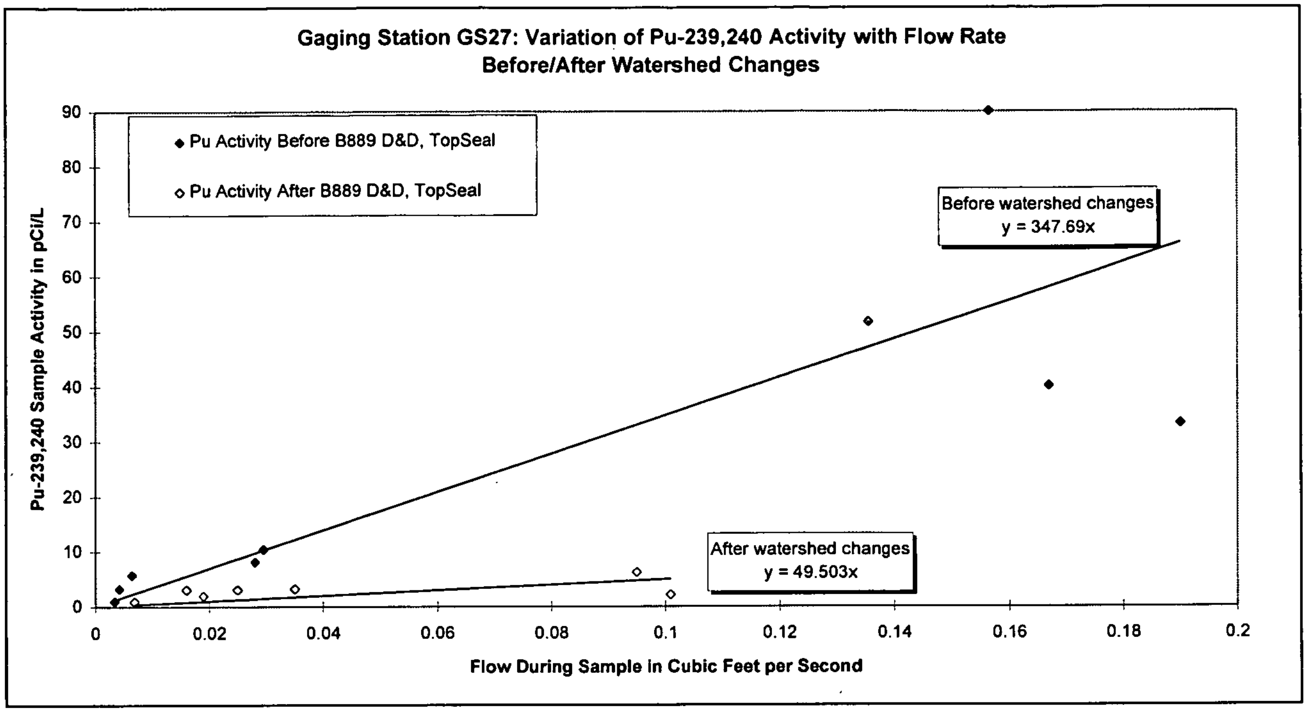

Figure 9-2. Gaging Station GS27: Variation of Pu-239,240 Activity with Flow Rate Before/After Watershed Changes.

Pu-239,240 activity versus TSS (Figure 9-3) - An increase in Pu activity is anticipated with a rise in TSS since it is generally acknowledged that actinides sorb to particulate matter (see references in Section 9.1). This plot indicates that, following the watershed changes, a reduced amount of Pu is associated with a given amount of TSS. This further implies that the watershed changes had one or both of the following results:

- The Pu source was partially removed from the basin (i.e., sediment removal or Building 889 D&D removed Pu from the basin) resulting in less Pu per unit of suspended solid; or
- The portion of the suspended solids that contains the greatest amount of Pu activity per unit mass, possibly the smallest particulate material with the greatest surface area to volume ratio, was fixed in place (i.e., the TopSeal was an effective fixative for the smaller particles). This resulted in a reduction in Pu per unit mass of suspended solid.

TSS versus Flow (Figure 9-4) - Binding particulate matter in place, or removing particulate matter from a drainage basin should theoretically reduce the amount of actinides (bound to solids) transported in runoff (see references in Section 9.1). This plot indicates that the amount of suspended solids in runoff at GS27 was reduced nearly threefold following the watershed change measures (i.e., TopSeal binding particulate matter in place or sediment removal reducing the available particulate matter to be transported). When combined with the reduction of Pu associated per unit of TSS, noted above, the combined effect results in the sevenfold decrease in Pu activity for a given flow rate that was previously discussed.

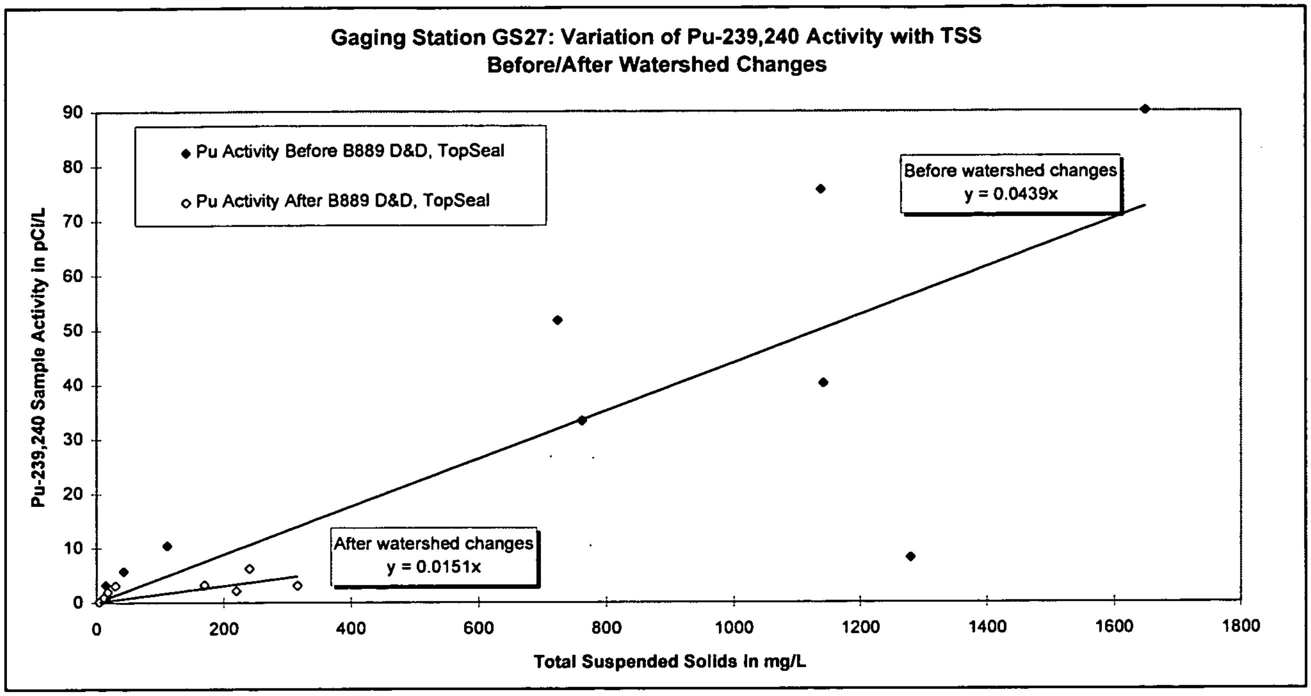

Figure 9-3. Gaging Station GS27: Variation of Pu-239,240 Activity with TSS Before/After Watershed Changes.

GS27 Data Summary:

Based on the data presented, it appears that watershed changes implemented in the GS27 basin during the Summer and Fall of 1996 reduced the amount of Pu transported in surface-water runoff in two ways. First, the amount of solids (TSS) flushed from the basin at a given flow rate appears to have been reduced. Second, the amount of Pu activity associated with a given amount of TSS appears to also have been reduced.

These changing relationships combined have resulted in a reduced amount of Pu activity measured for a given flow rate. Accordingly, this translates to a reduced Pu load transported out of the GS27 basin for a given volume of runoff.

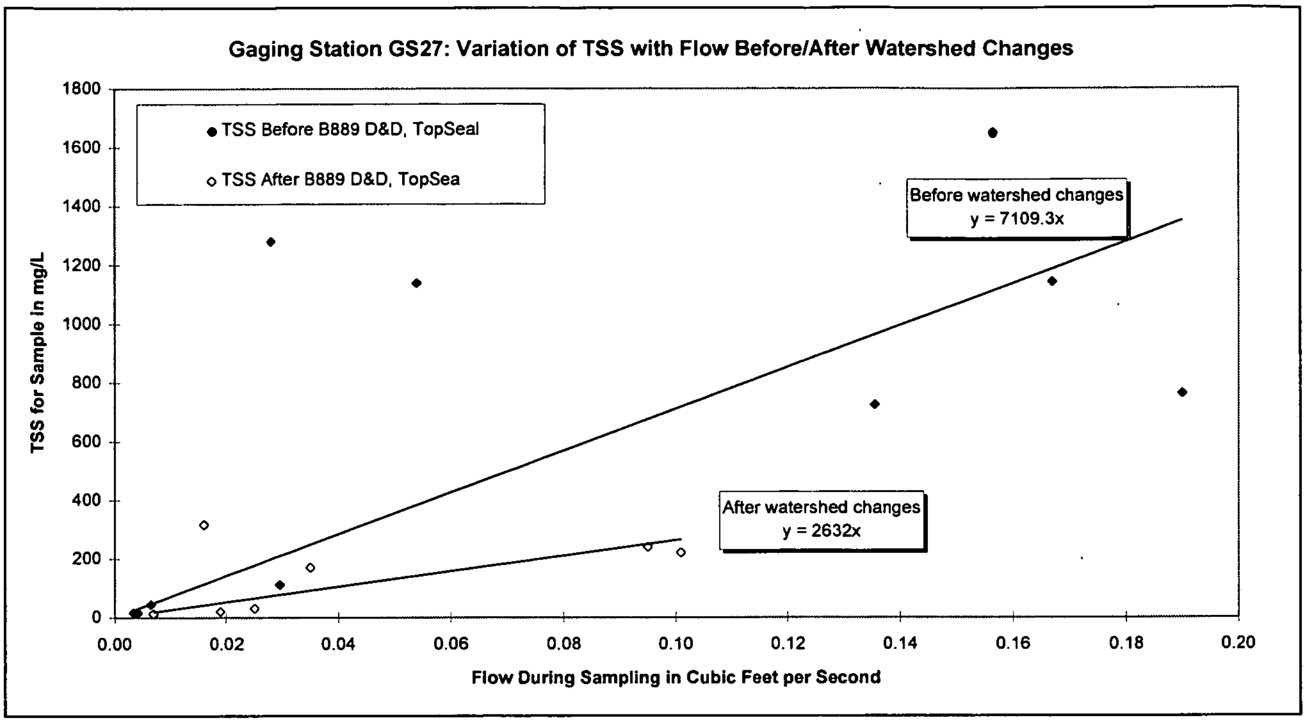

Figure 9-4. Gaging Station GS27: Variation of TSS with Flow Before/After Watershed Changes.

9.5. STATION SW091

Station Location: Northeast of the Solar Ponds, along on a small drainage swale outside of the Protected Area.

Basin Size: Approximately 12 acres

Basin Description: SW091 monitors flow from the exposed dirt area east of the Solar Ponds, within the Protected Area. Flow from SW091 goes into the North Walnut Creek, downstream from station SW093, and continues on to Pond A-3.

Watershed Improvements Implemented:
TopSeal® applied E. of Solar Ponds (1.8 acres; completed March 19, 1997)
SoilGuard® applied S.E. of Solar Ponds (0.1 acre; completed May 9, 1997)

SW091 Data Plots:

Storm-water runoff at this location is sporadic. Consequently, results from only two samples have been returned since the watershed changes were implemented. Further data needs to be collected before meaningful relationships can be established for before and after watershed changes.

9.6. STATION SW093

Station Location: Northeast of the Solar Ponds, on North Walnut Creek.

Basin Size: Approx. 232 acres

Basin Description: SW093 monitors flow from the north and northwest portions of the Industrial Area, including the northern half of the Protected Area. Flow from SW093 continues on to Pond A-3.

Watershed Improvements Implemented:
SoilGuard® applied E. of B779 (0.2 acre; completed June 24, 1996)
TopSeal® applied N.W. of Solar Ponds (0.5 acre; completed August 14, 1996)
TopSeal® applied E. of B779 (0.2 acre; completed April 14, 1997)

SW093 Data Plots:

Pu-239,240 activity versus time (Figure 9-5) - It should be noted that, because of RFCA requirements, the sampling methodology changed on October 1, 1996 from a storm-event sampling protocol to a continuous flow-paced method. The arithmetic average of Pu activity in samples collected before watershed changes (storm-event samples from WY93 through WY96: 0.734 pCi/L) is an order of magnitude higher than the Pu activity in samples collected after watershed changes (continuous flow-paced samples during WY97: 0.039 pCi/L). Assessing the impact of the watershed changes on reducing the Pu activity within this basin is therefore complicated by the changing sampling methodology that occurred concurrently.

Pu-239,240 activity versus flow (Figure 9-6) - The variation in slope between the "before" and "after" watershed changes trendlines is roughly 2:1. The change in sampling methodology, based on RFCA requirements and discussed above, could have been the cause for the reduced amount of Pu observed in sample results at this station. Analysis of this data to determine the effectiveness of the watershed improvements is, again, complicated by the change in sampling methodology.

SW093 Data Summary:

Two main points can be derived from the data presented for station SW093 regarding the effectiveness of the watershed improvements implemented in this basin. First, it is difficult to distinguish between the effect watershed changes had on water quality versus the effect caused by the change in sampling methodology. Second, the watershed changes instituted in the SW093 drainage basin comprised a small percentage of the overall basin area (less than one half of one percent of the SW093 basin). As a result, even if specific "hotspots" were treated, a dramatic change in the water quality for a larger, Industrial Area basin such as SW093 is difficult to demonstrate.

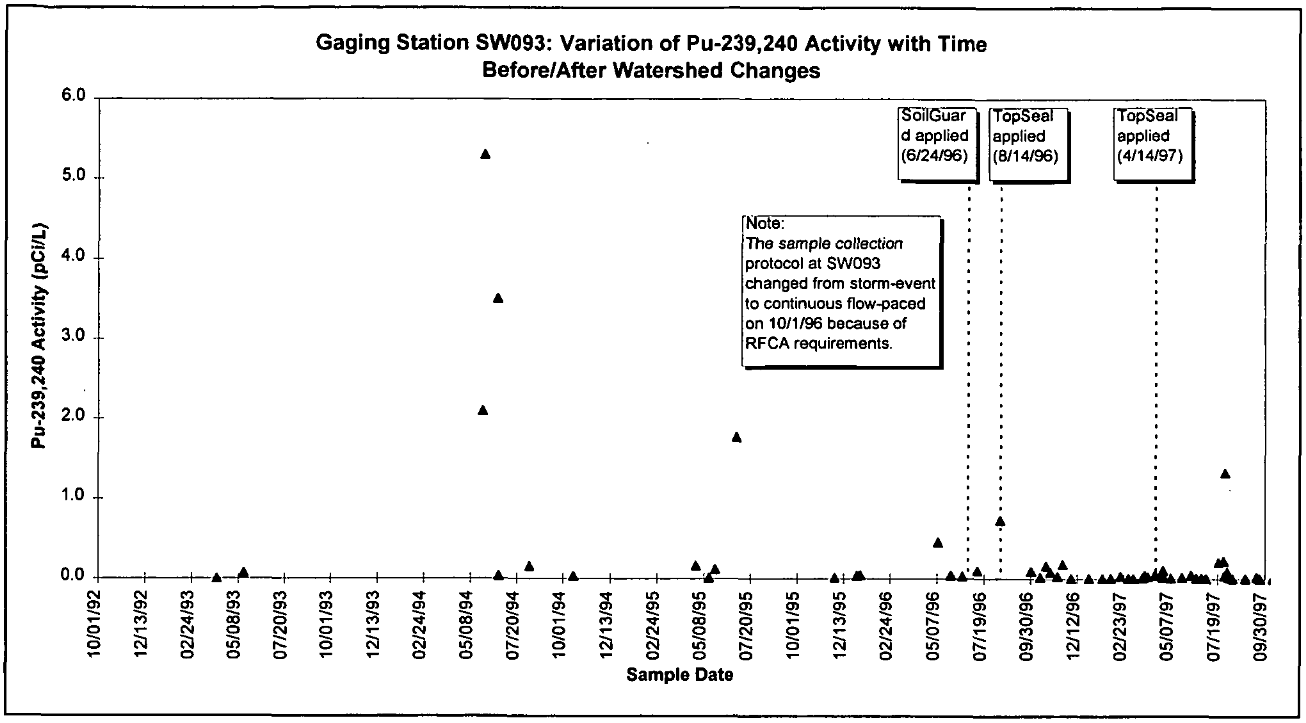

Figure 9-5. Gaging Station SW093: Variation of Pu-239,240 Activity with Time Before/After Watershed Changes.

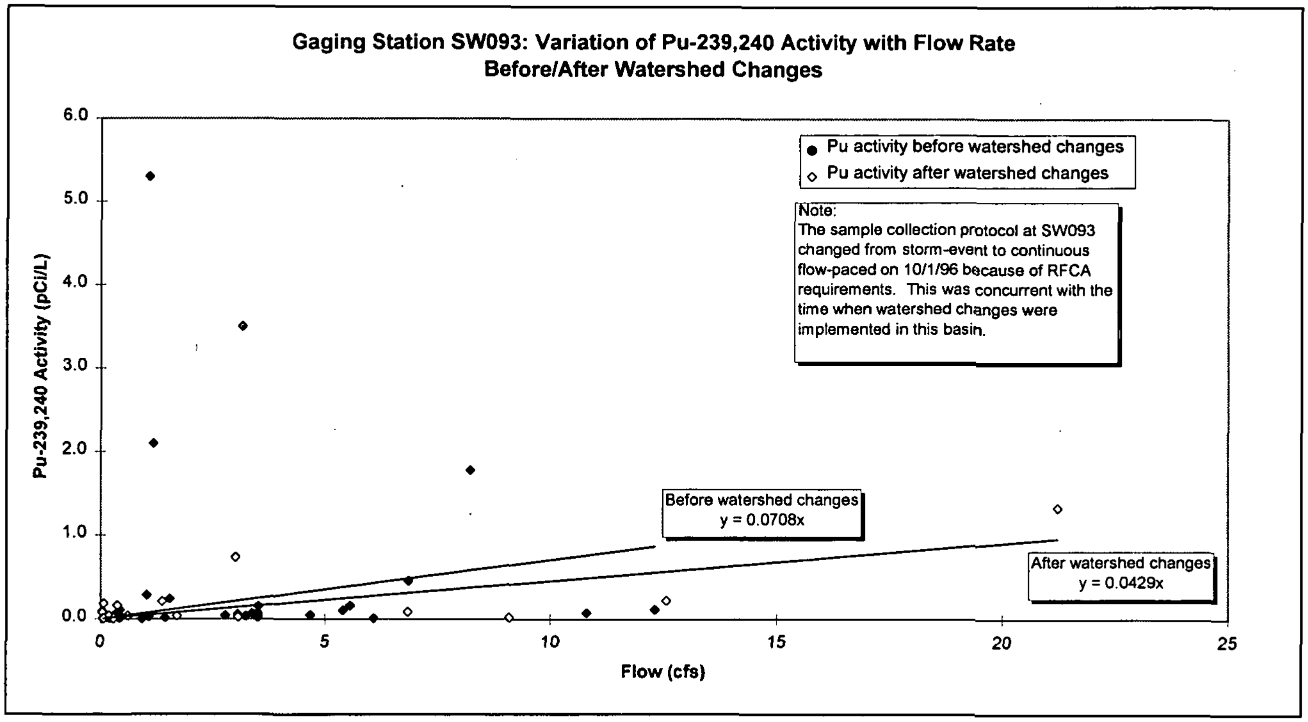

Figure 9-6. Gaging Station SW093: Variation of Pu-239,240 Activity with Flow Rate Before/After Watershed Changes.

9.7. STATION GS10

Station Location: East of the Industrial Area, along South Walnut Creek upstream from Pond B-1.

Basin Size: Approximately 180 acres

Basin Description: GS10 monitors flow from the central and southern portions of the Industrial Area, including the southeast portion of the Protected Area. The GS10 basin includes the sub-basin monitored by SW022 (and the GS27 sub-basin upstream from SW022). Flow from GS10 continues on to Pond B-5.

Watershed Improvements Implemented:
Sediments removed S. of B884 (7 drums; completed August 15, 1996) (Note: located in GS27 sub-basin)
TopSeal® applied S. of B884 (0.1 acre; completed October 1, 1996) (Note: located in GS27 sub-basin)
TopSeal® applied N.E. of B991 (0.2 acre; completed March 19, 1997)
TopSeal® applied E. of B707 (0.8 acre completed April 16, 1997)
TopSeal® applied along Seventh Street (0.3 acre; completed April 16, 1997)
SoilGuard® applied N.E. of B991 (0.1 acre; completed May 9, 1997)

GS10 Data Plots:

Pu-239,240 activity versus time (Figure 9-7) - Similar to station SW093, it should be noted that, because of RFCA requirements, the sampling methodology changed on October 1, 1996 from a storm-event sampling protocol to a continuous flow-paced method. The arithmetic average of Pu activity in samples collected before watershed changes in the GS10 basin (storm-event samples from WY93 through WY96: 0.237 pCi/L) is essentially the same as the Pu activity in samples collected after watershed changes (continuous flow-paced samples during WY97: 0.242 pCi/L). Assessing the impact of the watershed changes on reducing the Pu activity within this basin is complicated by the changing sampling methodology that occurred concurrently.

Pu-239,240 activity versus flow (Figure 9-8) - The variation in slope between the "after" and "before" watershed changes trendlines is roughly 2:1. However, the wide scatter of data, combined with the relatively similar average Pu activities for sampling before and after watershed changes (previously discussed), indicate that this figure does not provide clear trends for establishing the effectiveness of watershed changes in this basin.

GS10 Data Summary:

Similar to station SW093, the GS10 data is difficult to distinguish between the effect watershed changes had on water quality versus the effect caused by the change in sampling methodology. Also similar to SW093, the watershed changes instituted in the GS10 drainage basin comprised a small percentage of the overall basin area (less than one half of one percent of the GS10 basin). As noted previously, dramatic changes in the water quality of a larger, Industrial Area basin such as GS10 are difficult to demonstrate.

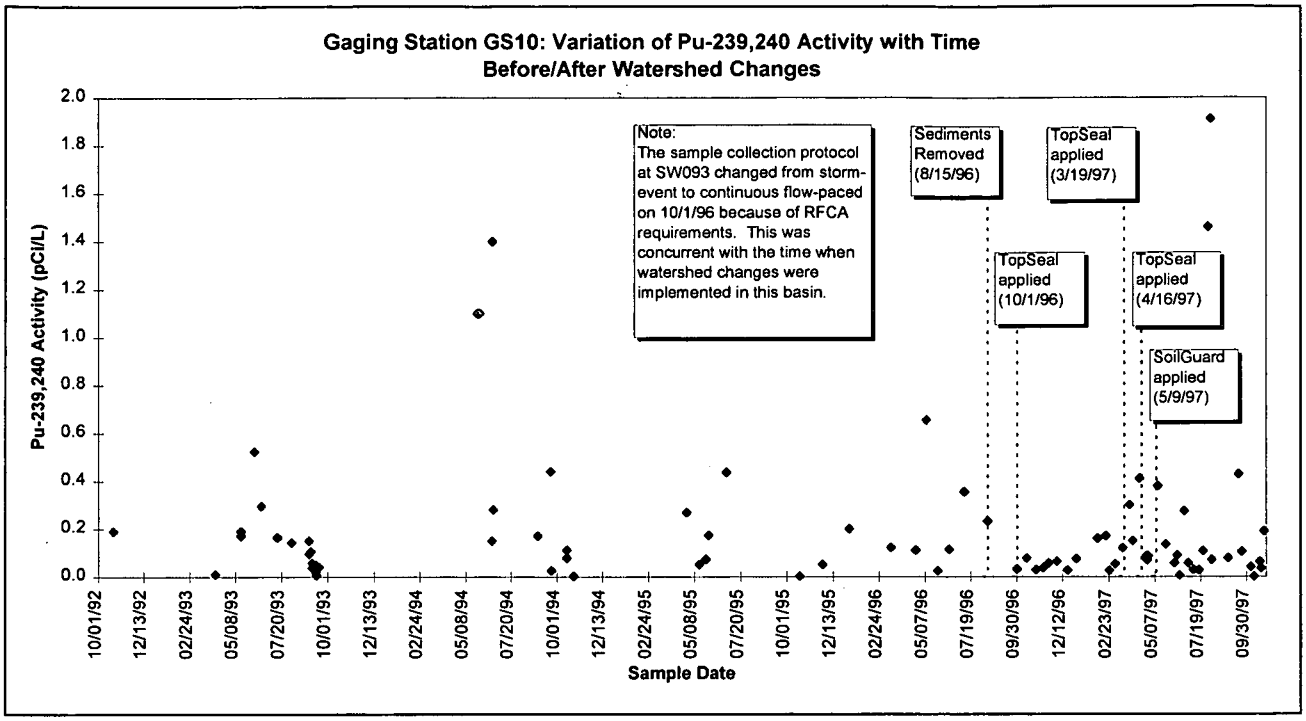

Figure 9-7. Gaging Station GS10: Variation of Pu-239,240 Activity with Time Before/After Watershed Changes.

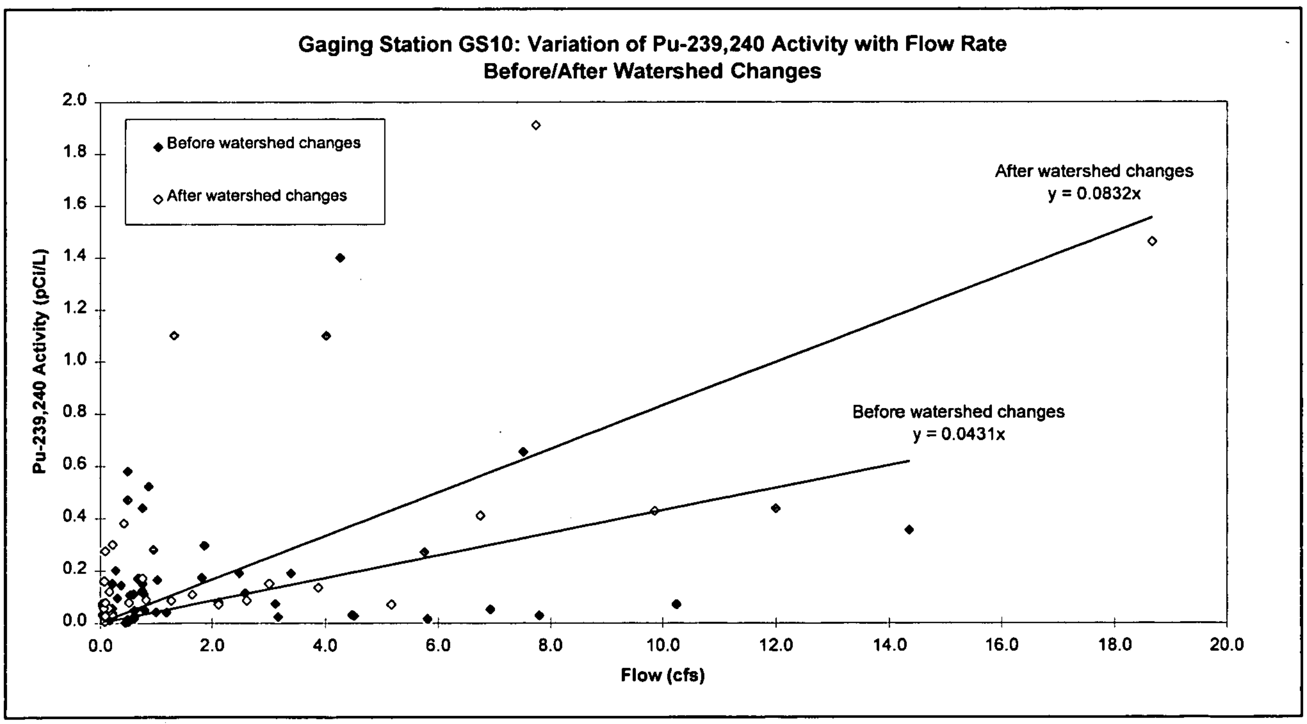

Figure 9-8. Gaging Station GS10: Variation of Pu-239,240 Activity with Flow Rate Before/After Watershed Changes.

10. PROGRAM STATUS: ISSUES AND HIGHLIGHTS

10.1. SAMPLING AND ANALYSIS

10.1.1. Verification of Elevated Analytical Results

Since Progress Report #1 all data returned to date from the analytical labs has met the required QA/QC criteria and no re-runs for questionable data have been requested.

10.1.2. Analytical Turn-Around-Times

The Site continues to request an accelerated sample turnaround for POC location GS03, however, in practice, the requested turnaround is not routinely met. Discussions with the Analytical Projects Office, Kaiser-Hill, are in progress to identify concerns and problems with sample turnaround. No FY98 funding has been identified to provide accelerated turnaround for the other four POC locations; however, this continues to be evaluated.

10.1.3. Analytical Data Validation

Funding issues concerning 100% data validation for all POCs also continue to be evaluated. As of the publication of this progress report, appropriate documentation to request funding for data validation is being completed and submitted for approval to Kaiser-Hill and DOE.

10.2. AUTOMATED SURFACE-WATER MONITORING

10.2.1. Continuous Flow-Paced Sampling

As part of the source evaluation, and in accordance with RFCA, continuous flow-paced and storm-event sampling has continued as specified in the SW IMP for North, South, and Lower Walnut Creek. Start and completion dates of samples for which analytical data have not yet been returned from the laboratory are presented in Table 10-1. No samples have been collected at GS08 since October 10, 1997 or at GS11 since December 5, 1997.

Upon receipt of laboratory results, 30-day moving average calculations will be updated as appropriate, and data will be included in the next report.

As reported in Progress Report #1, laboratories have been instructed to run TSS analysis on any samples which have not, by virtue of the sample collection duration, exceeded the maximum hold time of 7 days[23]. Collection of TSS information will aid in the determination of transport mechanisms for Pu, which tends to form strong associations with solids.

Table 10-1. Log of Recent Walnut Creek Samples.

Location	Gaging Station	Sample Start Date	Sample Collection Date
Lower Walnut Creek	GS03	10/30/97	11/21/97
		11/21/97	11/24/97
		11/24/97	11/28/97
		11/28/97	12/5/97
	GS11	11/21/97	11/24/97
		11/24/97	11/28/97
		11/28/97	12/5/97
North Walnut Creek	GS10	10/2/97	10/8/97
		10/29/97	11/7/97
		11/7/97	11/13/97
		11/13/97	12/1/97
	GS27	10/24/97	10/24/97
South Walnut Creek	SW093	10/6/97	10/13/97
		11/3/97	11/7/97
		11/7/97	11/10/97
		11/10/97	11/24/97
		11/24/97	12/1/97
		12/1/97	12/4/97

10.2.2. POC Gaging Station Upgrades

POC gaging stations in Walnut Creek and Woman Creek have been evaluated for winter freeze protection including outfitting with submersible heat tape/coils or other modifications to reduce the possibility of sample intake line freezing and the resulting gaps in sample collection. This will allow sampling equipment to more reliably collect water samples during extreme cold weather.

Heat tape systems that have been chosen require either 110v or 220v AC line power to provide adequate temperature regulation. The vendors that have been consulted have not recommended an attempt to

[23] TSS is not analyzed at Terminal Pond discharge points GS11 and GS08. TSS values at these locations are less than detection under normal discharge conditions. During emergency conditions where the Terminal Ponds would be discharged prior to the analysis of pre-discharge samples, TSS would be analyzed.

construct DC freeze-protection systems. AC line power currently exists at some sampling locations, but has proven to be unreliable, often failing during inclement weather. Therefore, AC supplies will need to be upgraded at most locations, while other locations will require complete construction of power lines to the gaging station.

In December, a temporary upgrade was completed at GS03 to provide freeze protection for sample collection. A stainless steel catch basin was installed at the sampler tube collection point, and fitted with a 400 Watt submersible heater. This heater provides the maximum power available due to existing power constraints.

WM&T personnel have consulted with RMRS engineering staff and construction cost estimators to formulate an accurate cost estimate on the modification and/or construction of reliable AC line power at POC monitoring locations. When the final project cost estimate is established, negotiations between RMRS and KH will commence to secure additional funding. Once the project is funded, contracts will be let to complete the installation of AC line power and freeze protection for sampler operations.

In addition to providing a cost estimate for AC line power, construction cost estimators are developing an estimate to upgrade the primary measuring device at GS01. Once the project is funded, contracts will be let to complete the upgrade to an adequate measuring device for all anticipated surface water flows.

10.2.3. Installation of Source Location Monitoring Locations

Tributary to GS03

Two new gaging stations, GS33 and GS35, have been installed upstream from GS03 in an effort to better characterize contributions to Walnut Creek from the major tributary subdrainages (see Figure 2-3). These stations were installed to support the Source Location Decision, as specified in the SW IMP. Collection of flow record and continuous flow-paced samples for laboratory analysis at these locations will facilitate loading calculations to determine which tributaries may be sources of contamination.

GS33 is located on No Name Gulch just above the confluence of No Name Gulch and Walnut Creek. Construction and instrumentation of GS33 was completed on September 15, 1997, and the location was immediately operational. The flow measurement device at GS33 is a 9.5-inch Parshall flume, capable of measuring flow rates up to 4.4 cfs. GS35 is located on McKay Ditch just above the confluence of McKay Ditch and Walnut Creek. Construction and instrumentation of GS35 was completed on September 18, 1997, and the location was immediately operational. The flow measurement device at GS35 is a 3-foot contracted rectangular weir, capable of measuring flow rates up to 18.4 cfs.

Both locations are equipped with electronic flow meters to collect 5- and 15-minute flow record and automated samplers programmed to collect continuous flow-paced composite samples. Power at each location is solar with battery backup. Operational protocols currently applied to maintain all RFCA surface-water monitoring locations will also be applied to GS33 and GS35. To date two composite samples have been collected from each location.

A third Source Location monitoring location will be installed during the first quarter of FY98. This gaging station, GS34, will be located on Walnut Creek, just upstream of the confluence of McKay Ditch (see Figure 2-3). This location will consist of a 1.5-foot Parshall flume equipped with the same flow measurement and sampling capabilities as GS33 and GS35. Instrumentation has been installed at GS34. The flume will be installed when it is received from the vendor, at which time continuous flow-paced sampling will begin.

Tributary to GS10

Three Source Location monitoring locations will be initially installed to continuously sample surface-water flows to further delineate the GS10 tributaries (Figure 10-1). Monitoring locations were determined based on the analysis of existing data to further scrutinize the GS10 drainage basin. These locations will employ flow control devices (e.g. flumes, weirs) and continuous flow-paced and/or synoptic storm-event sampling to calculate mass transport to determine which sub-drainages may be contributing contaminants. Water-quality information from sub-drainages may also indicate the degree to which source areas are localized or wide-spread. Additional monitoring locations may be installed to support the ongoing source evaluations. These locations will be targeted to further determine any localized source areas.

A concrete spillway east of the 700 Area on South Walnut Creek will be instrumented with a 1-foot Parshall flume. This location will monitor runoff from the areas around B776, 777, 778, 707, and 750. The small ditch north of the 904 Pad will be instrumented with a 1-foot H-flume and be identified as GS39. This location will monitor runoff from the areas around the 903 Pad, 904 Pad, and a portion of the Contractor Yard. Equipment has been installed, and the flume will be installed pending soil disturbance permits. Central Avenue Ditch just east of the corrugated metal pipe under 8th Street will be instrumented with a 9.5-inch Parshall flume and be identified as GS38. This location will monitor runoff downstream of the 100, 400, and 600 Areas, but be upstream of the 800 Area runoff contributions. Equipment has been installed, and the flume will be installed pending soil disturbance permits.

Tributary to SW093

Three Source Location monitoring locations will be initially installed to continuously sample surface-water flows to further delineate the SW093 tributaries (Figure 10-1). Also, SW118 has been upgraded with an automatic sampler. Monitoring locations were determined based on the analysis of existing data to further scrutinize the SW093 drainage basin. These locations will employ flow control devices (e.g. flumes, weirs) and continuous flow-paced and/or synoptic storm-event sampling to calculate mass transport to determine which sub-drainages may be contributing contaminants. Water-quality information from sub-drainages may also indicate the degree to which source areas are localized or wide-spread. Additional monitoring locations may be installed to support the ongoing source evaluations. These locations will be targeted to further determine any localized source areas.

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SW118 monitors runoff from areas north of the PA and portions of the 300 Area. A 1-foot H-flume will be installed in the ditch north of the Solar Ponds along the PA Perimeter Road, just west of GS32. This location will monitor runoff from the areas around B774, 771, 371, 374, 776, and 777. A 1-foot Parshall flume will be installed in the gully east of B374 and upstream from the Metrology Lab. This location will monitor runoff from the areas around B559, 776, 566, 371, and 374. A 9.5-inch Parshall flume or rectangular weir will be installed in the small ditch west of Tank 231B. This location will monitor runoff from portions of the 100, 300, and 500 Areas.

10.3. SOIL AND SEDIMENT SAMPLING

10.3.1. Proposed Soil Sampling in GS03 Drainage

Upon receipt of additional funding, Phase II soil sampling from the drainage areas contributing to flow at surface water monitoring station GS03 (on Walnut Creek at Indiana Street) will be implemented. Phase II sampling locations will be guided by Phase I sampling results. Phase I sediment sampling was conducted at 19 locations detailed in Progress Report # 2. The intent of this sampling is to evaluate for spatial variability which may indicate the extent of distributed contaminated soils or a tributary contributing contaminated sediments through overland runoff.

A Sampling and Analysis Plan will be developed to investigate the extent of contamination that may have contributed to the elevated analytical measurements at GS03. The contaminants of concern for this investigation are Pu, Am, and U. Currently, the sampling locations and number of samples to be collected are undetermined. Funding constraints may be restrictive in the Phase II soil sampling effort. However, this soil sampling may be collected as part of the Actinide Migration Studies.

10.3.2. New Locations Tributary to GS10 and SW093

Soil and sediment samples will be collected from the drainage tributary to GS10. Locations of these samples will be determined based on the analysis of new and existing data. Particular attention will be given to the results of the loading analysis for existing stations and proposed Source Location stations (see Section 10.2.3). These sediment/soil locations will be sited to indicate spatial activity variations and to fill any gaps in existing data. Sediment/soil activities from the drainage pathways tributary to GS10 and SW093 will be analyzed for spatial variability which may indicate the location of a source area. Summary statistics for these new values will be evaluated against historical results in the area to indicate changes. Additionally, these values will be compared to surface-water radionuclide activities in a loading context.

Additional soil and sediment sampling is anticipated in support of the ongoing source evaluations. These samples will be targeted to further define any localized source areas.

10.4. ACTINIDE MIGRATION STUDIES

As discussed in previous Progress Reports, the Site has undertaken comprehensive multi-year Actinide Migration Studies to improve understanding of the behavior and transport of Pu, Am, and U in the environment. This understanding of actinide migration will provide insight into the nature and movement of potential sources at RFETS.

In FY97 the Actinide Migration Studies group collected and analyzed soil and sediment samples for Pu loading and by sequential extraction techniques designed to uncover Pu's associations with chemically identifiable soil fractions. This information will be used in Site cleanup in evaluating long-term protectiveness of soil action levels on surface water and on long-term surface-water compliance at Site closure. The report which discusses the results of FY97 work was released on December 16, 1997 and has been sent to regulators and stakeholders. This report is currently undergoing peer review by Dr. Greg Choppin of Florida State University.

10.4.1. Consultation with Actinide Migration Advisory Group

The Walnut Creek Source Evaluation task team has consulted with the Actinide Migration Studies Advisory Group and provided the latest source-evaluation information (that available through the October 28, 1997) in the presentations and discussions at the FY97 Results Discussion and Model Development Meeting, October 27-28, 1997.

Additional source-investigation tasks which were recommended by Actinide Migration experts (and discussed in previous Progress Reports) are planned or remain under consideration by the Source Evaluation task force. These are further evaluated in Table 10-2.

Table 10-2. Remaining Actinide Migration Study Recommendations

Recommendation	Actions Taken to Date / Status
1. Collect TSS samples with normal sampling.	TSS samples are planned for grab samples taken to support this investigation; the use of regular automated sampling to collect TSS samples is frustrated by the hold time limitation of 7 days.
2. Calculate/trend Pu-to-Am ratios for the elevated samples versus historical results.	Planned for FY98. WM&T personnel have begun evaluation under direction of Actinide Migration experts.
3. Examine relative analytical errors including counting, MDA, etc. (taking into account propagation of errors) to determine significance exceedance Evaluate minimum detectable activity and analytical uncertainty to determine their impact on compliance.	Detection limit issues and variability are being considered.
4. Determine Pu-240/Pu-239 isotopic ratios on exceedance planchets to assist in identifying source(s)	Planchets are preserved awaiting isotopic assay in FY98.

Recommendation	Actions Taken to Date / Status
5. With 4 individual samples returned with >0.15 pCi/L (Pu) consider the importance of "bunching" or fortuitous grouping (non-randomness) and its impact on compliance.	Statistical methods will be applied to the data.
6. Perform TSS, total organic carbon (TOC), and filtered/unfiltered radiochemistry as needed to address particle size of contaminant.	There may be technical limitations placed by automated sampling method and will require special grab sampling. Sampling and analyses will be planned to avoid hold-time and sampling-protocol issues (e.g., plastic carboys used in the current automated sampling program cannot be used for TOC samples).

10.5. SUMMARY

The Site is in close communication with regulators, cities, and stakeholders regarding the status of source evaluations and monitoring programs. WM&T personnel provided a presentation on Progress Report #2 at the December 2, 1997 Surface Water Issues Meeting (SWIM). Table 10-3 is a recent Weekly Project Status Report (December 22, 1997) issued by the Site.

The Final Source Evaluation Report and Mitigating Action(s) Plan to be submitted on April 15, 1998 will include the final assessment of the source evaluation for GS03, GS10, and SW093. This Report will also include recommendations for any mitigating actions deemed appropriate and effective in improving water quality. If source evaluations prove inconclusive at that time, additional evaluation will be considered. Mitigation actions will be targeted and designed based on the results of the source evaluation actions. The following will be included in the Final Report for Walnut Creek:

- Results and analysis of ongoing RFCA monitoring;
- An assessment and incorporation of available new data for GS03, GS10, and SW093;
- An identification of data gaps and uncertainties in the source evaluation process with suggested modifications (if any) to the Actinide Migration Study Workscope and the SW IMP;
- A summary of current Actinide Migration Study findings with cross-links to source evaluations;
- A summary of the status for sampling and operational modifications;
- Results of the source location evaluation;
- A detailed description of identified source areas;
- A detailed description of mitigating actions applicable to each identified source area; and
- Scope, schedule, and budget for the proposed mitigating actions.

Table 10-3. Weekly Project Status Report: December 22, 1997.

	Project Activity	Sched. Start	Sched. Finish	Status	Comment
1	Verify laboratory results and 30-day average calculations for the May-June 1997 GS03 water quality measurements.	8/14/97	8/15/97	**Completed**	Verified laboratory results; re-checked 30-day average calculations. Lab results passed QA/QC; details are published in Progress Report #1 delivered on 9/30/97.
2	Perform "walk down" of stream channel and adjacent areas between Pond A-4 and GS03 looking for any unusual conditions which might indicate new sources.	8/15/97	8/15/97	**Completed**	Observed no unusual conditions in Walnut Creek that would indicate a localized source area; several minor stream bank cuts and stream bottom fill locations were noted. Details are published in Progress Report #1 delivered on 9/30/97.
3a	Confirm that water quality measurements at GS03 have returned to normal levels.	8/14/97	NA	Seventeen carboys have been collected at GS03 and submitted for analyses.	Awaiting results for carboys which initiated sampling on 10/30 (baseflow sampling), 11/21, 11/24, and 11/28. Analytical results received for carboys collected over the following sampling periods: <u>Period: Pu Result in pCi/l</u> 10/27 - 10/30: 0.002 pCi/L

	Project Activity	Sched. Start	Sched. Finish	Status	Comment
3b	Continue to collect composite, flow paced samples at GS10 to assess trends.	6/17/97	N/A	Since 7/15, eighteen carboys have been collected at GS10 and analyzed.	Awaiting results for carboys which initiated sampling on 10/29, 11/7, and 11/13. Analytical results received for carboys collected over the following sampling periods: Period: Pu Result in pCi/l 10/13 - 10/22: -0.01 pCi/L 10/22 - 10/24: 0.062 pCi/L
3c	Continue to collect composite, flow paced samples at SW093 to assess trends.	9/17/97	N/A	Since 9/18, 11 carboys have been collected at SW093 and analyzed.	Awaiting results for carboys which initiated sampling on 10/6, 10/27, 11/3, 11/7, 11/10, 11/24, and 12/1. Analytical results received for carboys collected over the following sampling periods: Period: Pu Result in pCi/l 10/13 - 10/23: -0.001 pCi/L 10/23 - 10/27: 0.009 pCi/L
4	Re-analyze remaining sample aliquots for two of three elevated composite samples from GS03.	8/14/97	8/21/97	**Completed**	One result confirmed original measurement; other sample failed re-analysis.

	Project Activity	Sched. Start	Sched. Finish	Status	Comment
5	Perform appropriate notifications to Site personnel and Stakeholders regarding elevated (May-June 1997) measurements at GS03.	8/15/97	8/15/97	**Completed**	Site and Stakeholders were notified. Notifications included both Occurrence Reporting and RFCA reporting contacts. Occurrence report filed 8/15/97. Regulators notified through RFFO on 8/15/97.
6	Perform sediment sampling in Walnut Creek upgradient drainages tributary to GS03	8/21/97	8/21/97	**Completed**	Collected 3 pond bottom samples from pond at Walnut and Indiana; and 16 samples from streambeds upgradient; preliminary results were submitted for validation on 9/17/97. Validated data were received on 9/23/97. These data were posted and sent out as a map attachment to Flash Brief #5 on 10/1/97. Data interpretation was incorporated in Progress Report #2 completed on 11/18/97.
7a	Perform additional sediment and soil sampling upgradient of GS03.	Approx. 9/1/97	Approx. 9/30/97	**Completed**	Additional samples will be collected if needed for further investigation of stream bed sediments. In September, soil samples were collected from eroded materials near the GS03 flumes. Two additional samples were collected at the GS03 flume pond on 9/9/97. Unvalidated results for this sampling event are 0.023 pCi/l Pu for the sample taken north of the flume and 0.071 pCi/l Pu for the sample taken south of the flume.

	Project Activity	Sched. Start	Sched. Finish	Status	Comment
7b	Perform additional soil sampling upgradient of GS03.	Approx. 1/16/98	Approx. 2/5/98	**Pending additional funding. Additional funding was requested on 11/18.**	Additional soil samples will be collected upgradient of GS03 to further investigate potential source areas tributary to Walnut Creek. The current S&A Plan will be modified to include DQOs to identify sources and generally characterize soil Pu levels in Walnut Creek basin between the Landfill Pond and terminal ponds downstream to GS03. Modifications to the SAP are underway.
8a	Accelerate appropriate analyses to ensure timely data availability.	8/21/97	9/5/97	**Completed**	Accelerated sample turnaround to maximize data availability for decision making.
8b	Perform value engineering analysis to support acceleration of compliance monitoring.	9/6/97	9/30/97	**Completed**	Evaluated laboratory costs, turn-around times, and data quality. Collected and compared costs of accelerated analytical turnaround. Per K-H, all GS03 samples through end of FY97 will be expedited for two (2) week turn-around. Expected that turn-around will continue into FY98 for GS03.

	Project Activity	Sched. Start	Sched. Finish	Status	Comment
9a	Perform laboratory services check.	8/21/97	9/15/97	**Completed**	QC samples are routinely collected according to RFCA technical design document (every 20th sample). This continues as designed. K-H has requested all POC's data be validated for FY98 sampling. Cost have been estimated for the accelerate turn-around. Additional funding has been requested from on November 18, 1997.
9b	Submit additional sample duplicates, splits, rinsates, and blinds	9/15/97	11/15/97	**Completed**	The need for additional QC sampling has been evaluated. The current QC sampling is consistent with the requirements as specified in the Integrated Monitoring Plan. Sample duplicates are collected at the minimum frequency of one per 20 field samples. The frequency of collection of equipment rinsate samples will be increased to approximately one per 20 samples. Since most RFCA samples are analyzed by only one laboratory, splits and blinds can not be done. Also note that all POC samples analysis are 100% validated.

	Project Activity	Sched. Start	Sched. Finish	Status	Comment
10a	Compile all existing water, soil, and sediment radio-analytical results for GS03, GS10, and SW093 and associated upgradient locations.	8/21/97	9/15/97 for GS03 11/17/97 for GS10 12/31/97 for SW093	**Completed for GS03** **Completed for GS10** **Completed draft for SW093 12/19/97**	Evaluations for GS03 were presented in Progress Report #1 delivered on 9/30/97. Evaluations for GS10 were presented in Progress Report #2 delivered on 11/17/97. Awaiting comments on draft.
10b	Interpret all existing water, soil, and sediment radio-analytical results for GS03, GS10, SW093, and associated upgradient locations.	9/15/97	9/30/97 for GS03 11/17/97 for GS10 12/31/97 for SW093	**Completed for GS03** **Completed for GS10** **Completed draft for SW093**	Detailed summary and analysis were published in Progress Report # 1 and #2 delivered on 9/30/97 and 11/17/97, respectively. Updates will be presented in Progress Report #3 on 12/31/97. Awaiting comments on draft.

	Project Activity	Sched. Start	Sched. Finish	Status	Comment
11	Perform loading and fate and transport analyses. Evaluate statistical correlations using water-quality, flow, and precipitation.	8/21/97	9/30/97 for GS03 11/17/97 for GS10 12/31/97 for SW093	**Completed for GS03** **Completed for GS10** **Completed draft for SW093**	Evaluation is ongoing to aid in the definition of near-term activities; results and hypotheses will be made available as they are developed. Hydrologic, precipitation, and WQ results are evaluated for trends and correlations. Careful consideration was given to the difference in results and hypotheses; interim results and evaluation were published in Progress Report #1 and Progress Report #2 delivered on 9/30/97 and 11/17/97, respectively. Updates for GS03 and GS10 will be presented in Progress Report #3 on 12/31/97.
12	Perform synoptic sampling event in Walnut Creek for the first 24-hours of the upcoming Pond A-4 discharge.	8/25/97	8/30/97	**Completed**	This event monitoring utilized seven (7) automated samplers to collect time-paced composite samples for the first day of Pond A-4 discharge (8/29 - 8/30/97), effectively sampling the same (initial) 'plug' of water as it moves through the Walnut Creek drainage. The samplers performed flawlessly with each composite sample receiving the targeted 75 grabs. Grab samples for TOC and DOC were also taken on the rising limb of the discharge as an indicator parameter to define potential correlations. Accelerated WQ results will be used to evaluate for water-quality trends. Flash Brief #5 (10/07/97) presented sediment sampling results that were not included in Progress Report #1. (Late receipt of validated data precluded inclusion in the Progress Report #1.) Data are currently being validated under direction of APO. Results and associated evaluation were included in Progress Report #2 on 11/17/97.

	Project Activity	Sched. Start	Sched. Finish	Status	Comment
13a	Install additional monitoring stations upstream of GS03.	8/25/97	9/15/97	**Completed** **2 of 3**	New gaging station locations selected and readiness approvals received for installation. Locations will collect continuous flow-paced samples to assess transport in No Name Gulch, McKay Ditch, and Walnut Creek. Ecological approvals completed 8/27/97; soil disturbance approvals completed. Gaging station GS33, on No Name Gulch at Walnut Creek, was installed 9/10/97. Gaging station GS35, on McKay Ditch at Walnut Creek, was installed 9/12/97. Startup and operation began on 9/15/97 for both locations. A flume is currently being procured for gaging station GS34, on Walnut Creek upstream of McKay Ditch. Prefabrication of the structure to support the sampling, monitoring, and telemetry equipment is complete. Currently waiting on delivery of the flume and good weather for installation. GS33 has collected composite samples for the periods 10/28-10/29 and 10/29-11/13. The current carboy was installed and started on 11/13.

	Project Activity	Sched. Start	Sched. Finish	Status	Comment
13a	continued				GS35 collected 2 samples for the periods 10/27-10/29 and 10/29-10/30. The carboy currently collecting samples at GS35 started sampling on 10/30. Analytical results received for GS35 carboys collected over the following sampling periods: Period: Pu Result in pCi/l 10/29 - 10/30: 0.001 pCi/L
13b	Install additional monitoring stations upstream of GS03 if needed to provide increased resolution.	9/30/97	12/31/97	Ongoing	Information derived from the new gaging stations will be used to determine whether additional locations are needed.
13c	Install additional source location monitoring station upstream of GS10.	10/1/97	11/1/97	Ongoing	Three source location monitoring station installations are expected. Locations and descriptions of these stations are given in Progress Report #2. Most equipment has been procured and received. Soil disturbance permits are pending and ecological evaluations are complete. Instrumentation partially deployed at 2 of 3 locations.

	Project Activity	Sched. Start	Sched. Finish	Status	Comment
13d	Install additional source location monitoring station upstream of SW093.	10/1/97	11/1/97	Ongoing	Three source location monitoring station installations are expected. Locations and descriptions of these stations are given in Progress Report #2. Most equipment has been procured and received. Soil disturbance permits have been initiated and ecological evaluations are complete. Instrumentation complete and sampling initiated at SW118 on 11/30.
13e	Install freeze protection at monitoring location GS03.	12/3/97	12/17/97	Pending	Stainless steel sample intake basin and submerged freeze protection was installed on 12/8. Additional heat tape freeze protection pending.
14a	Examine impact of RFCA watershed improvements on downstream WQ.	9/30/97	12/31/97	Ongoing	Watershed improvements were performed in FY96 and FY97. WQ results are being compiled and analyzed to provide information on contaminant transport. Information will be published in Progress Report #3 on 12/31/97.
14b	Review historical release report(s) for possible correlation with RFCA monitoring results.	9/8/97	9/30/97 for GS03 11/17/97 for GS10 12/31/97 for SW093	**Completed for GS03** **Completed for GS10** **Completed draft for SW093**	Historical releases for the Walnut Creek drainage will be reviewed to determine whether past releases may have contributed to the elevated Pu and Am measurements. Results for GS03 were published in Progress Report #1 delivered on 9/30/97. Results for GS10 were published in Progress Report #2 delivered on 11/17/97. Awaiting comments on draft.

	Project Activity	Sched. Start	Sched. Finish	Status	Comment
15	Evaluate all Site activities potentially impacting GS03 water quality.	8/21/97	9/30/97 for GS03 11/17/97 for GS10 12/31/97 for SW093	**Completed for GS03** **Completed for GS10** **Completed draft for SW093**	Results and evaluation were published in Progress Report #1 and Progress Report #2 delivered on 9/30/97 and 11/17/97, respectively. Awaiting comments on draft.
16	Perform additional walkdowns to assess No Name Gulch and McKay Bypass ditch sub-drainages and to identify origin of baseflow.	8/20/97	8/20/97	**Completed**	Drainages show indication of recent high flow rates (likely from large storm events in first weeks of Aug./97). Baseflow was confirmed exiting pond at GS03 with no inflow noted. No indication of current baseflow from seeps or springs; no unusual conditions which may visually indicate a localized source area. Details were published in Progress Report #1 delivered on 9/30/97.
17a	Identify data gaps and uncertainties in monitoring approach and protocols to improve monitoring program.	8/18/97	9/30/97	**Completed**	Initial evaluation of pacing and baseflow sample collection frequency and developed changes to sampling protocols that minimize chances of low-volume samples. Findings and protocol changes were published in Progress Report #1 delivered on 9/30/97.
17b	Continue to identify data gaps and uncertainties in monitoring approach and protocols to improve monitoring program.	9/30/97	12/31/97	Ongoing	Detailed evaluation of pacing and baseflow sample collection frequency and developed changes to sampling protocols that minimize chances of low-volume samples.

	Project Activity	Sched. Start	Sched. Finish	Status	Comment
18a	Share recent developments and information with the K-H Team's Actinide Migration investigators and solicit additional source evaluation hypotheses.	8/29/97	9/15/97	**Completed**	RMRS completed data exchange and consultation with Dr. Bruce Honeyman (CSM) on August 29th. Meeting minutes were distributed on Sept. 3rd and recommendations incorporated into the Plan for Source Evaluation and Preliminary Actions for Walnut Water-Quality Results. Extra sediment was set aside (from that collected on 8/21/97) to allow for independent evaluation by Actinide Migration investigators.
18b	Continue to share recent developments and information with the K-H Team's Actinide Migration investigators and refine source evaluation hypotheses.	10/27/97	4/15/98	**Ongoing**	The October meetings on Actinide Migration Studies was held October 27-28, 1997 to provide updates and other technical information on the Actinide Migration Study and the Walnut Creek source investigation. Solicited recommendations on additional study areas.
19	Evaluate ground water data for wells in the vicinity of GS03, GS10, and SW093.	8/21/97	9/30/97 for GS03 11/17/97 for GS10 12/31/97 for SW093	**Completed for GS03** **Completed for GS10** **Completed draft for SW093**	Results and associated evaluation were included in Progress Report #1 and Progress Report #2 delivered on 9/30/97 and 11/17/97, respectively. Awaiting comments on draft.
20	Complete and provide draft of RFCA-required *Plan for*	6/17/97	7/17/97	**Completed**	Delivered draft *Plan* to regulators 7/17/97; comments on *Plan* from regulators received 8/5/97 and 8/7/97.

	Project Activity	Sched. Start	Sched. Finish	Status	Comment
	Source Evaluation and Preliminary Mitigating Actions for Walnut Creek Water-Quality Results ("*Plan*").				Response to comments sent to DOE 8/27/97 for transmittal to regulators. May-June 1997 water-quality results from GS03 were addressed in latest revision of *Plan*. *Plan* was amended to perform source evaluations for Walnut Creek basin above GS03 and GS10.
21	Complete *Final Plan for Source Evaluation and Preliminary Mitigating Actions for Walnut Creek Water-Quality Results*	8/5/97	9/15/97	**Completed**	Provided draft for internal K-H Team on 9/10/97; transmitted to DOE 9/12/97; and transmitted to regulators on 9/15/97.
22a	Complete Progress Report #1 for the *Plan*	8/21/97	9/30/97	**Completed** **Delivered on 9/30/97**	Progress Report #1 included analysis and evaluation of historic reports and readily available information and environmental data for GS03 and preliminary analysis for GS10. Initial conclusions regarding source were formulated and incorporated in this report. Data received after 9/15/97 were not included in this report.

	Project Activity	Sched. Start	Sched. Finish	Status	Comment
22b	K-H Team personnel (Chris Dayton, Keith Motyl, with technical support from George Squibb) provided, in a roundtable fashion, an update/briefing to Stakeholders on recent developments in the Walnut Creek Source Evaluation on 10/ 16. Representatives of EPA, CDPHE, local cities, CAB, DOE, and K-H Team participated.	10/16/97	10/16/97	**Completed**	SUMMARY ♦ Recent sediment data and synoptic sampling results (from that received recently from the laboratories but collected in August and not covered in the most recent Progress Report #1) were presented and discussed. The tone was cordial and rarely confrontational. ♦ On balance, Stakeholders agreed that investigation had discounted several hypothetical causes and perhaps the best remaining candidate was diffuse legacy source(s) and that a distinct source was not indicated by the so work so far. ♦ Bill Fraser of EPA closed the meeting by noting that the Stakeholder group believed RF was responsive and thorough in their source investigation and appeared to be doing everything possible to ID the source(s). ♦ In closing Westminster complimented RF on the quality and understandability of Progress Report #1.

	Project Activity	Sched. Start	Sched. Finish	Status	Comment
23	Complete Progress Report #2 for the *Plan*.	10/1/97	11/17/97	**Completed and delivered on 11/18/97**	Progress Report #2 includes analysis and evaluation of existing GS10 and GS03 data and the newly acquired GS03 data and other necessary environmental information as determined by the Phase 1 activities. Report #2 includes a preliminary assessment of SW093. Conclusions regarding GS10 and GS03 sources were refined after inclusion of the new data and incorporated in this report.
24	Complete Progress Report #3 for the *Plan*.	11/18/97	12/31/97	**Completed draft 12/19/97**	A draft of Progress Report #3 includes analysis and evaluation of all GS10, GS03, and SW093 investigative information and environmental data was completed 12/19/97. Comments will be considered and incorporated when received.
25	Complete Final Evaluation Report and Mitigating Action Plan addressing elevated Walnut Creek sources.	1/1/98	4/15/98	Pending	The Final Evaluation Report will include the results and conclusions of the source evaluation actions. The Mitigating Action Plan will evaluate options (cost, efficacy, etc.) and identify alternatives for effectively removing and/or reducing impacts of identified sources.

RFP-1325.02 (REV. 10/97)
Previously RF-46522

CORRES. CONTROL
INCOMING LTR NO.

01778 RF 97

DUE DATE

ACTION

DIST.	LTR	ENC
BACON, R.F.		
BENSUSSEN, S.J.		
BORMOLINI, A.M.		
BRAILSFORD, M.D		
BURDGE, L		
CARD, R.G.		
COSGROVE, M.M.		
COULTER, W.L.		
CRAWFORD, A.C.		
DERBY, S.		
DIETERLE, S.E.		
FERRERA, D.W.		
FERRERA, K.P.		
GERMAIN, A.L.		
HARDING, W.A.		
HARROUN, W.P.		
HEDAHL, T.G.		
HERRING, C.L.		
HILL, J.A.		
MARTINEZ, L.A.		
NORTH, K.		
PARKER, A.		
PHILLIPS, F.J.		
RHOADES, D.W.		
RUSCITTO, D.G.		
SANDLIN, N.B.		
SPEARS, M.S.		
TILLER, R. E.		
TUOR, N.R.		
VOORHEIS, G.M.		
COR. CONTROL	X	X
ADMN RECORD	X	
PATS/T130G		

Reviewed for Addressee
Corres. Control RFP

12/2/97 Date By

Ref Ltr. #

DOE ORDER # 5400.1

2 DEC 97 1:42

RFETS-CC

Department of Energy

ROCKY FLATS FIELD OFFICE
P.O. BOX 928
GOLDEN, COLORADO 80402-0928

97-DOE-05

DEC 2 1997

Ms. Mary Harlow
Department of Public Works and Utilities
City of Westminster
4800 W. 92nd Avenue
Westminster, CO 80030

Dear Ms. Harlow:

I apologize that my October 9, 1997, letter was not mailed to you, and regret the delay in responding to your letter of September 24.

Thank you for your comments on the plan for "Source Evaluation and Preliminary Proposed Mitigating Actions for Walnut Creek Water-Quality Results, dated September, 1997 (the "Plan We will take these comments under advisement during the development of the Progress Repor to the Plan and the Final Plan. We strive to keep you fully informed on current surface water activities at the Rocky Flats Environmental Technology Site through the documents provided t you---such as the weekly Surface Water Project Status Summaries, the Surface Water Flash Briefs, and Progress Report #1 to the Plan--as well as participation in the monthly Surface Wat Issues Meetings and the quarterly Data Exchange Meetings. We believe that participation in these meetings provides the ideal forum for technical discussions of surface water issues and encourage you to raise issues, like those identified in your September 24th letter, during these meetings. If you feel that these meetings do not provide you with sufficient opportunity to discuss your issues, we would be happy to meet with you for further dialogue.

Feel free to contact me at 966-4839 if you have any questions or would like to set up a meeting to discuss issues that you may have.

Sincerely,

John C. Morris
for Steve Slaten
RFCA Project Coordinator

cc:
J. Legare, AMEC, RFFO
J. Karpatkin, CED, RFFO
B. April, RLG, RFFO
J. Stover, RLG, RFFO
M. Anderson, OCED, RFFO
Administrative Record

DEC 1997
RECEIVED
RECORDS CENTER

ADMIN RECORD
A-OU06-000542

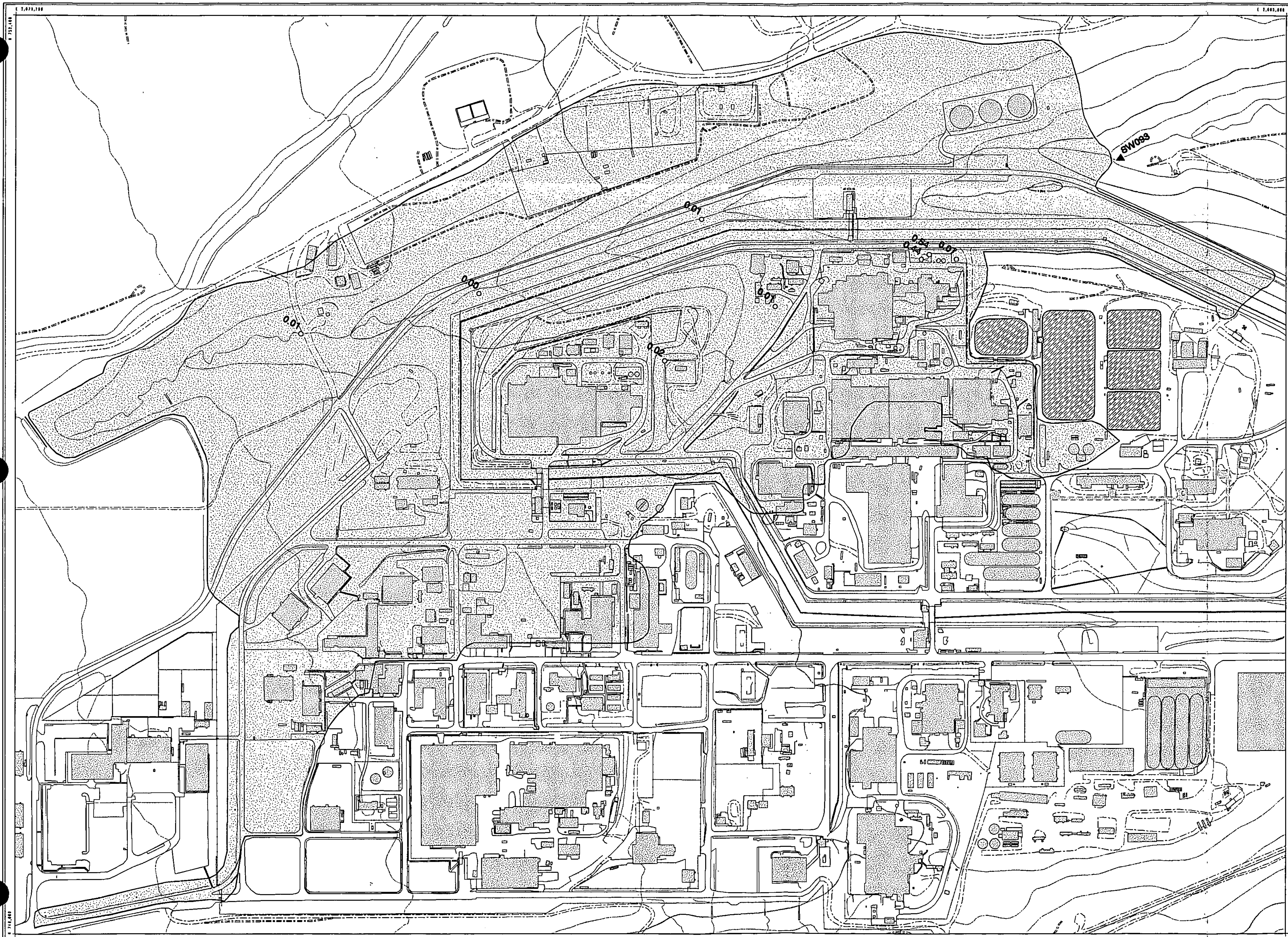

Figure 7-17

Surface Water Sampling Locations Tributary to SW093

Maximum Pu (pCi/L)

EXPLANATION

Monitoring Locations

▲ Point of Evaluation

○ Selected Surface Water Sampling Locations

Drainage

GS10 Drainage

Standard Map Features

Buildings and other structures

Solar evaporation ponds

Lakes and ponds

Streams, ditches, or other drainage features

Fences and other barriers

Contour (20-Foot)

Paved roads

Dirt roads

DATA SOURCE:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the othophotographs. 1/95
Topology (contours) were derived from digital elevation model (DEM) data by Morrison Knudson (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours. The DEM data was capture by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at 10 (?) meter resolution. The DEM post-processing perfromed by MK, Winter 1997.

Scale = 1 : 5670
1 inch represents approximately 473 feet

100 0 200 400ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by:

RMRS Rocky Mountain Remediation Services, L.L.C.
Geographic Information Systems Group
Rocky Flats Environmental Technology Site
P.O. Box 464
Golden, CO 80402-0464

MAP ID: 98-0042-Map4

December 23, 1997

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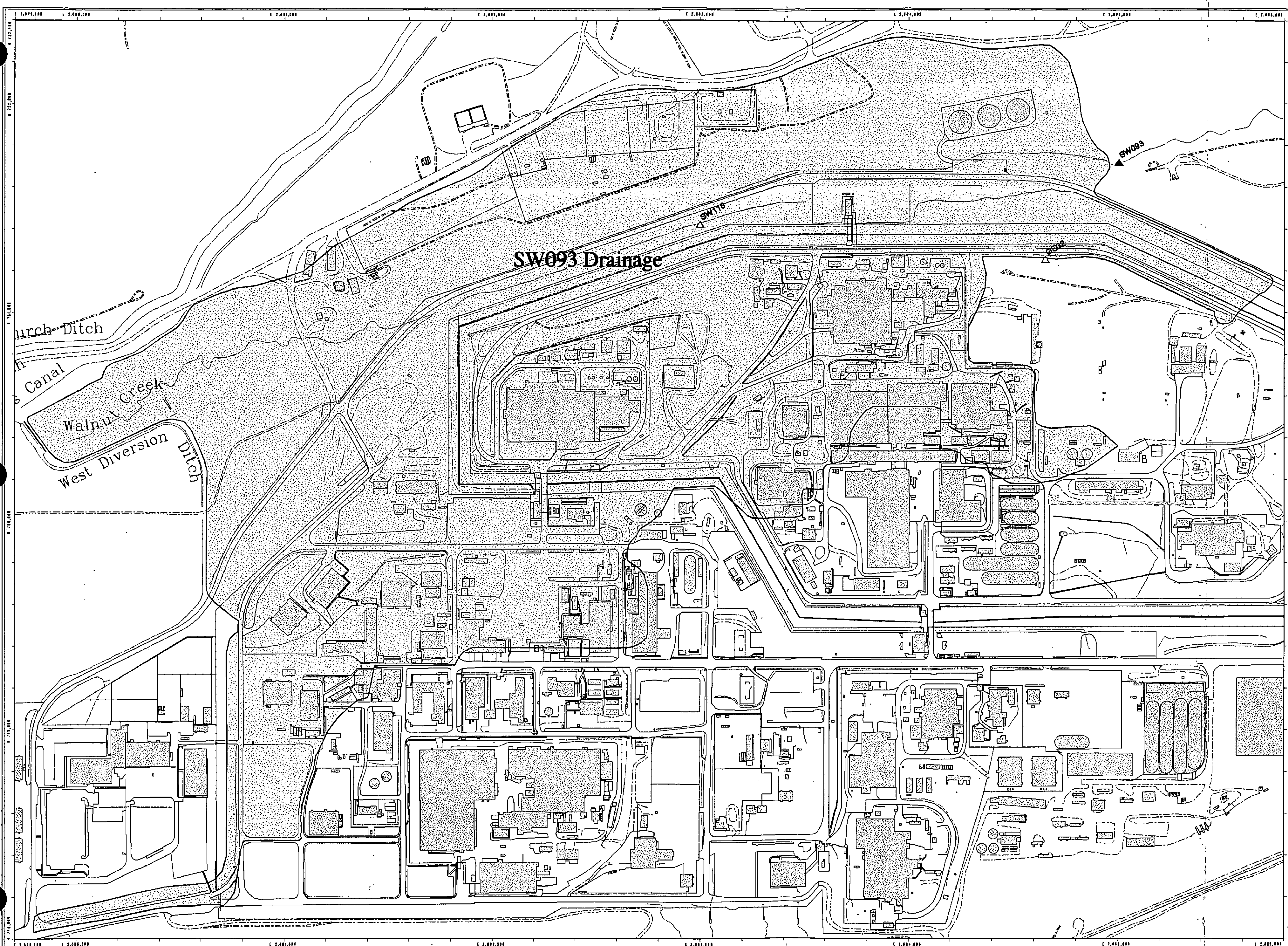

Figure 7-1

Selected Surface-Water Monitoring Locations Tributary to SW093

Legend

Monitoring Locations

▲ Point of Evaluation

△ Performance

△ Source Location

Drainage

SW093 Drainage

Standard Map Features

Buildings and other structures

Lakes and ponds

Streams, ditches, or other drainage features

Fences and other barriers

Rocky Flats boundary

Paved roads

Dirt roads

DATA SOURCE:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the othophotographs. 1/95

Scale = 1 : 5670
1 inch represents approximately 473 feet

100 0 200 400ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

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Prepared by:

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Golden, CO 80402-0464

MAP ID: 98-00042-Map3

December 23, 1997

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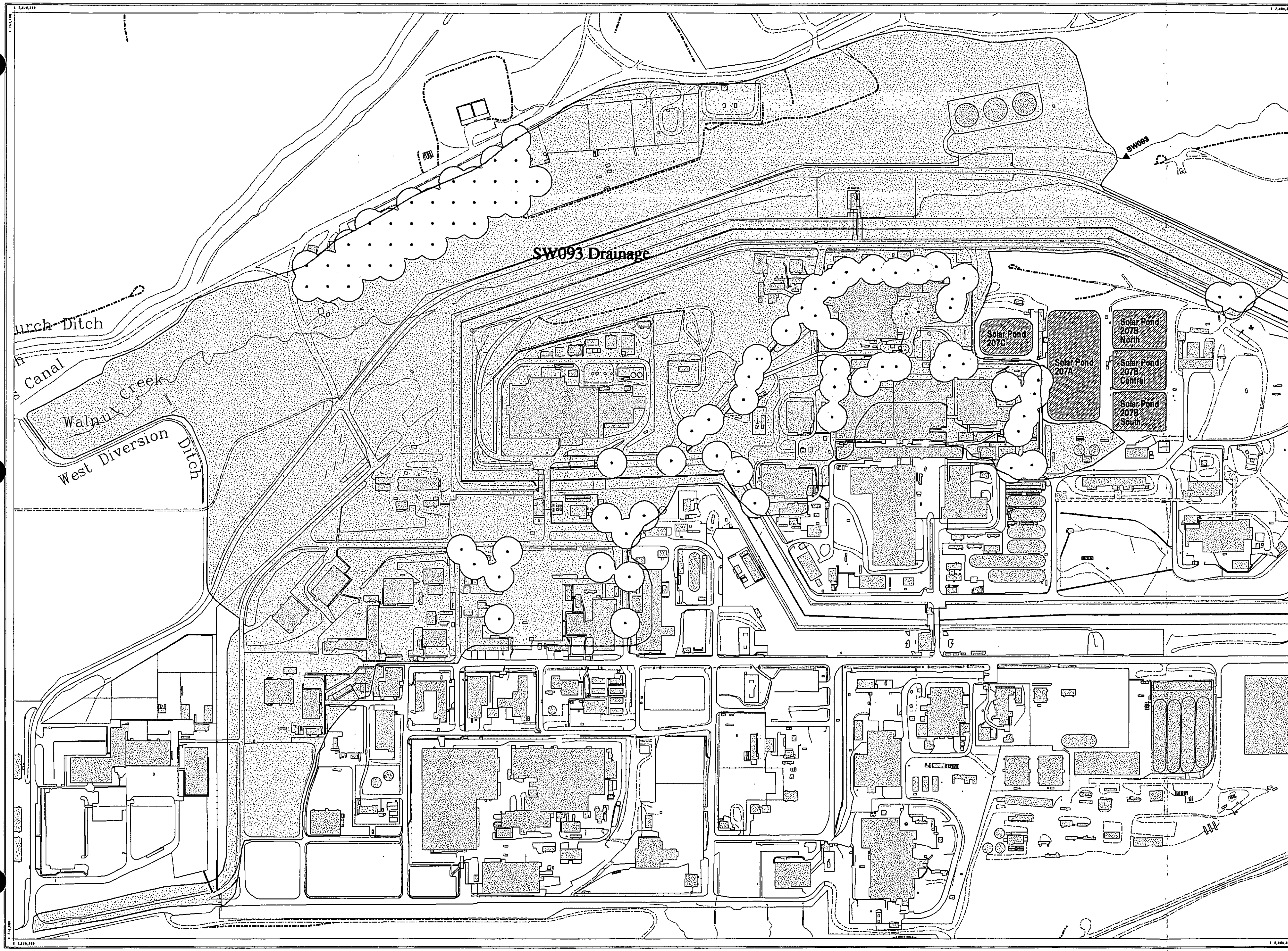

Figure 7-18

Gamma Spectioscopy Data in SW093 Drainage Pu-239 nCi/g

EXPLANATION

HPGe Data Ranges--

- 0.0 - 0.1
- 0.1 - 1
- 1 - 10
- 10 - 100
- 100 - 1000
- 1000 - 10000

Drainage

- SW093 Drainage

Standard Map Features

- Buildings and other structures
- Solar evaporation ponds
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Rocky Flats boundary
- Paved roads
- Dirt roads

NOTE:
Raw field data which has not been evaluated and may be influenced by building shine.

The HPGe field of view (FOV) or radius of influence assumes a homogeneous surface distribution. The FOV represents a circle where 90% of the flux originates. The radius, for each HPGe sampling location, is based on the height of the detector above the ground.

DATA SOURCE:
HPGe data from Ron Reiman, Gamma Survey Group, Safeguard Measurements, EG&G Rocky Flats, Inc. June 1994
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the othophotographs. 1/95

Scale = 1 : 5450
1 inch represents approximately 454 feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy

Rocky Flats Environmental Technology Site

Prepared by:

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Geographic Information Systems Group
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P.O. Box 464
Golden, CO 80402-0464

MAP ID: 98-00042-Map5

December 23, 1997

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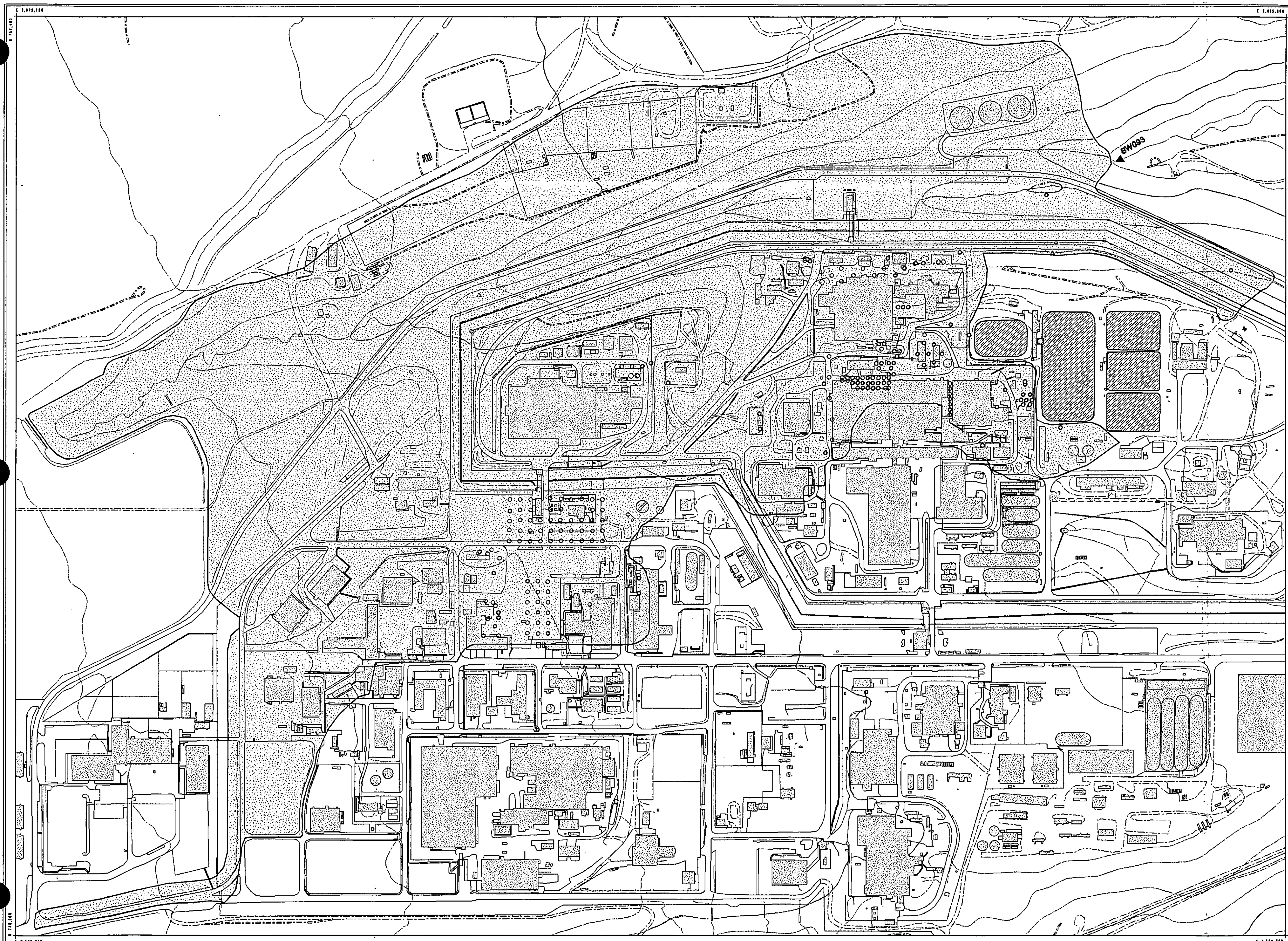

Figure 7-19

Surface Soil & Sediment Sampling Locations Tributary to SW093

EXPLANATION

Legend

Pu Activity pCi/g

- -0.1 - 0.1
- 0.1 - 1.0
- 1.0 - 10.0
- 10.0 - 100.0
- 100.0 - 1000.0
- Greater than 1000.0

Monitoring Locations

- Point of Evaluation
- Surface Soil Samples
- Sediment Samples

Drainage

- SW093 Drainage

Standard Map Features

- Buildings and other structures
- Solar evaporation ponds
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Contour (20-Foot)
- Paved roads
- Dirt roads

N

Scale = 1 : 5670
1 inch represents approximately 473 feet

100 0 200 400ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

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MAP ID: 98-0042-map6

December 23, 1997

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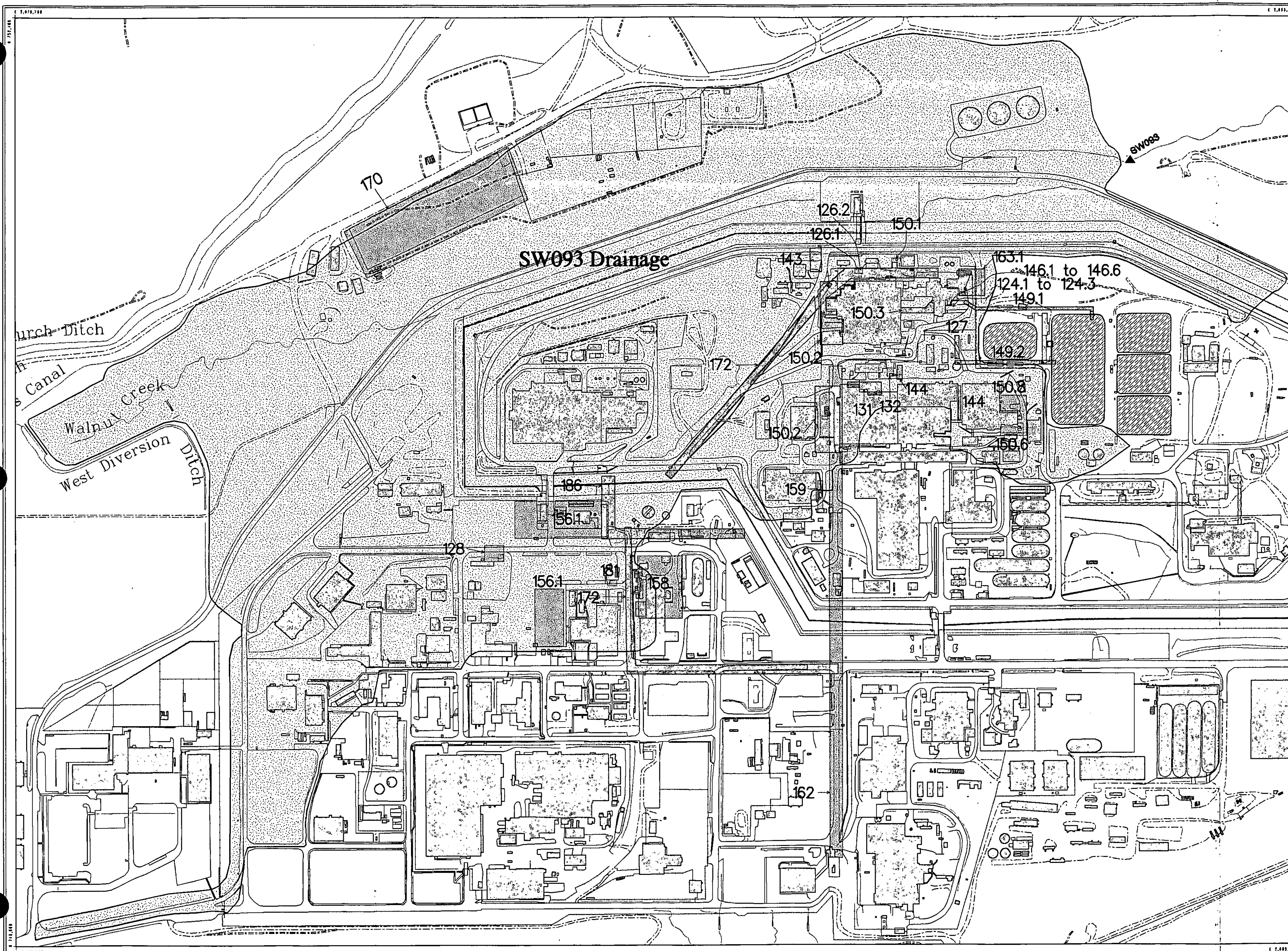
Figure 7-21

IHSSs Tributary to SW093



Legend

- Plutonium IHSS Locations
- General Radionuclide (RAD) IHSS locations

Drainage

- SW093 Drainage

Standard Map Features

- Buildings and other structures
- Solar evaporation ponds
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Rocky Flats boundary
- Paved roads
- Dirt roads

DATA SOURCE:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the othophotographs. 1/95

Scale = 1 : 5670
1 inch represents approximately 473 feet

100 0 200 400ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

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Rocky Flats Environmental Technology Site

Prepared by:
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Golden, CO 80402-0464

MAP ID: 98-00042-Map7 December 23, 1997

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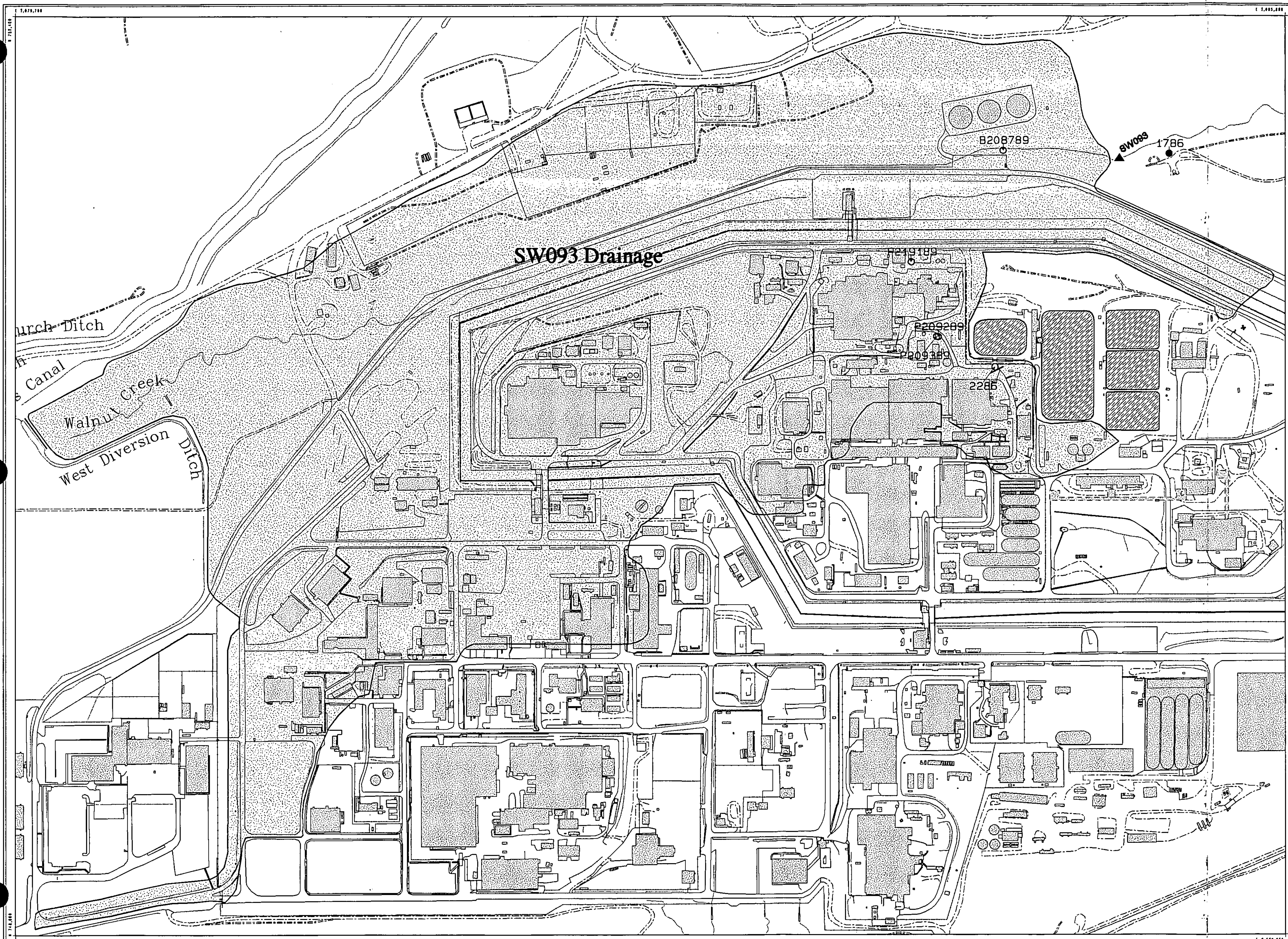

Figure 7-23

Selected Groundwater Monitoring Wells

Legend

- ▲ Surface Water Monitoring Location
- ○ Groundwater Well (Currently sampled for Pu & Am)
- ○ Groundwater Well (With historical record of total Pu > = 0.15pCi/L)
- ● Groundwater Well (Not currently sampled for Pu)

Drainage

- SW093 Drainage

Standard Map Features

- Buildings and other structures
- Solar evaporation ponds
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Rocky Flats boundary
- Paved roads
- Dirt roads

DATA SOURCE:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the othophotographs. 1/95

N

Scale = 1 : 5670
1 inch represents approximately 473 feet

100 0 200 400 ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

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MAP ID: 98-00042-Map8 December 23, 1997

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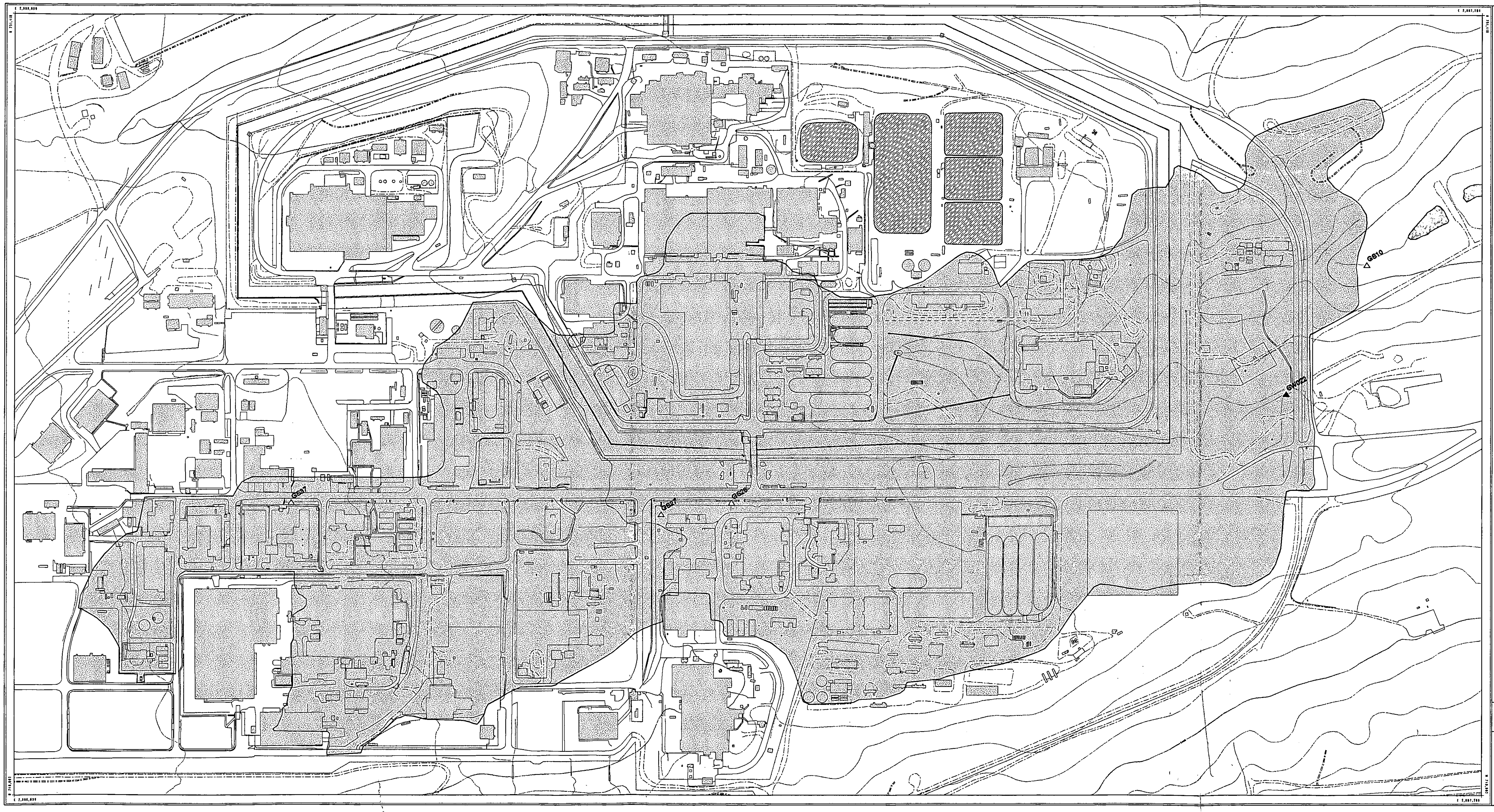

Figure 5-1

Selected Surface Water Monitoring Locations Tributary to GS10

EXPLANATION

Monitoring Locations

- △ Point of Evaluation
- △ Performance
- ▲ New Source Detection

Drainage

- GS10 Drainage

Standard Map Features

- Buildings and other structures
- Solar evaporation ponds
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Contour (20-Foot)
- Paved roads
- Dirt roads

DATA SOURCE:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the othophotographs. 1/95
Topology (contours) were derived from digital elevation model (DEM) data by Morrison Knudson (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours.
The DEM data was capture by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at 10 (?) meter resolution.
The DEM post-processing perfromed by MK, Winter 1997.

Scale = 1 : 4230
1 inch represents approximately 353 feet

100 0 200 400ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

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Rocky Flats Environmental Technology Site

Prepared by:
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Golden, CO 80402-0464

MAP ID: 98-0042-Map2 December 29, 1997

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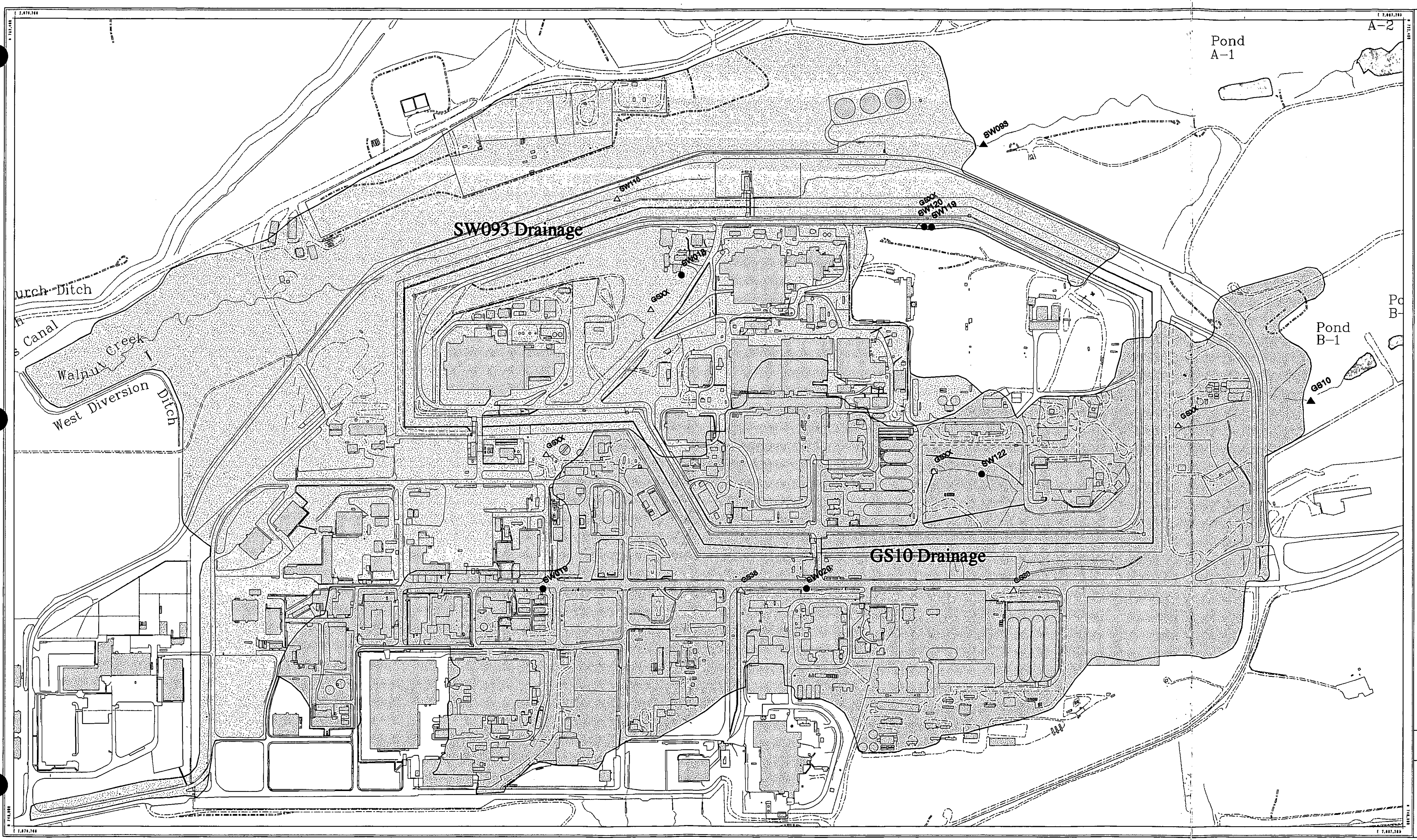

Figure 10-1

Proposed Source Location Monitoring Stations for GS10 & SW093 Drainage Areas

Legend

Monitoring Locations

- ▲ Point of Evaluation
- △ Proposed Source Location Station
- ● Surface Water Sampling Location

Drainage

- SW093 Drainage
- GS10 Drainage

Standard Map Features

- Buildings and other structures
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Rocky Flats boundary
- Paved roads
- Dirt roads

DATA SOURCE:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the othophotographs. 1/95

Scale = 1 : 5580
1 inch represents 465 feet

100 0 200 400ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by:

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Golden, CO 80402-0464

MAP ID: 98-00042-Map9

December 29, 1997

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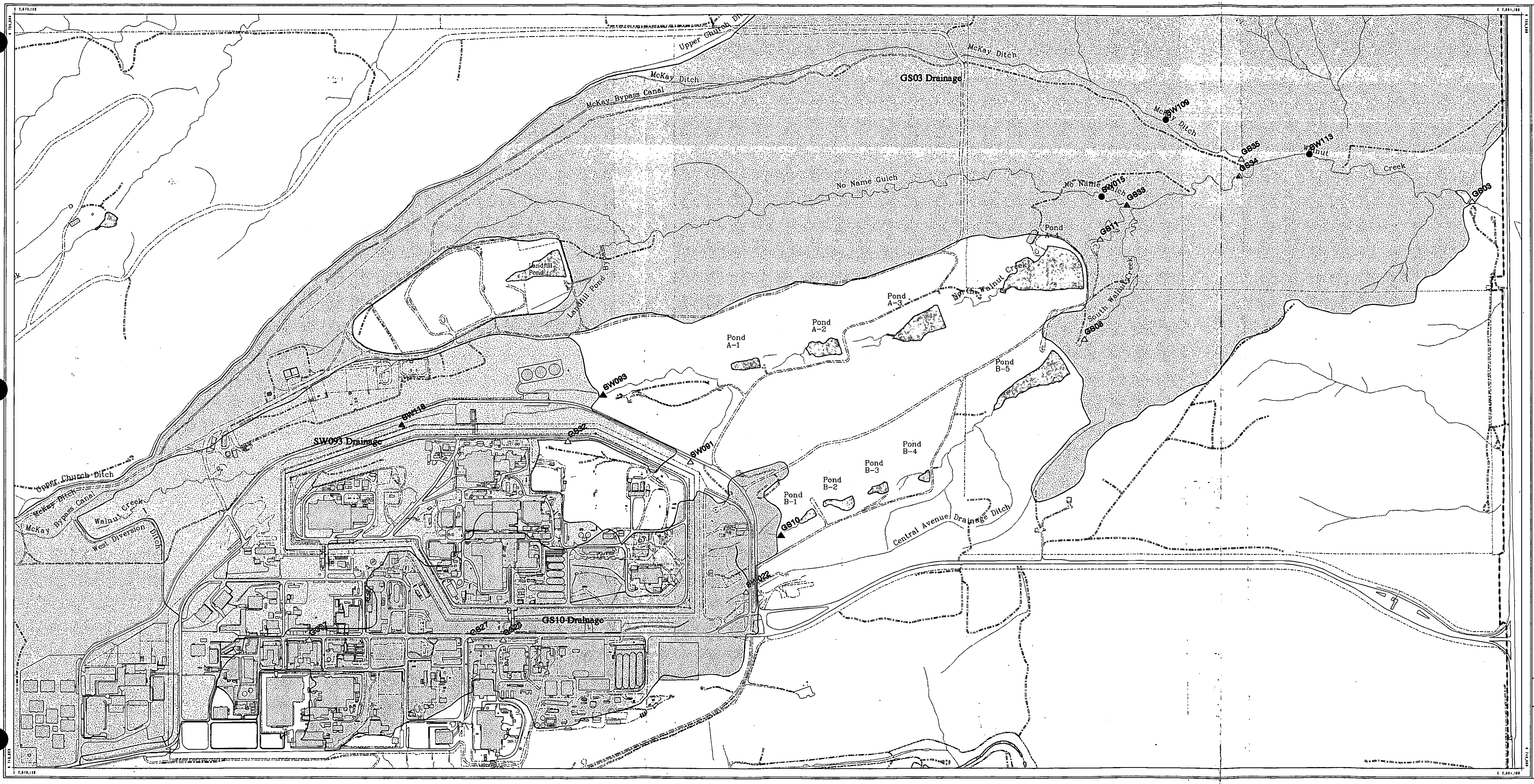
Figure 2-3

Selected Surface-Water Monitoring Locations in Walnut Creek



Legend

Monitoring Locations

- Point of Compliance
- Point of Evaluation
- Performance
- Source Location
- New Source Detection
- Surface Water Sampling Location

Drainages

- GS03 Drainage
- SW093 Drainage
- GS10 Drainage

Standard Map Features

- Buildings and other structures
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Rocky Flats boundary
- Paved roads
- Dirt roads

DATA SOURCE:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the othophotographs. 1/95

Scale = 1 : 9700
1 inch represents approximately 808 feet

250 0 500 1000ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by:
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MAP ID: 98-0042-Map1

December 23, 1997

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